BIRD

# Water Supply for Locomotives

Railway Engineering
B. S.

1901

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# Water Supply for Locomotives

. . BY . .

FREDERICK JOEL BIRD

## THESIS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN

RAILWAY ENGINEERING

IN THE

COLLEGE OF ENGINEERING

OF THE

UNIVERSITY OF ILLINOIS

PRESENTED JUNE, 1901

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May 31, 1901 190

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Frederick Joel Bird

ENTITLED Water Supply for Locomotives

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Railway Engineering.

L. P. Breckenridge

HEAD OF DEPARTMENT OF Mechanical Engineering.

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# Review of the Water Supply Stations on the Peoria and Eastern Railway.

Thesis F. J. Bird.

This investigation of the Water Pumping Stations on the Peoria and Eastern Railway was undertaken in order to determine their general condition, cost of maintainance, cost of operation, and the possibilities of improvement in this last item.

This thesis is a continuation of the one written on the same subject last year by Mr. E. L. Mayall and, where possible, use has been made of the results of his investigation.

In the following matter each station has been treated separately. A general synoysis and summary will be found at the end. The investigation and the calculation of results at each station was divided into the four parts as follows:

1. General Inspection of Plant.

Under this head the following information was obtained:

Date of installation.
Distance of pumping plant from station.
Name of pump and size.
Kind of boiler and size.
Kind of tank and size.
Kind of support for tank and height.
Kind of buildings and size.
Length and height of suction pipe.
Length and height of discharge pipe.
Length and size of all other pipes.
Kind of well and depth.

Number of water columns.

Sketches were made of the general arrangement of pump, pump house, coal house, tank, track, and piping.

Sketches were also made of the pump house showing the pump, the boiler and the the piping.

2. Efficiency test and determination of the coefficient of discharge of the pump.

   (a) In the efficiency test a careful account was kept, throughout the test, of the weight of coal consumed, the weight of water evaporated and the quantity of water pumped.

With these data it was possible to determine the weight of water evaporated per pound of coal, the weight of coal consumed in pumping one thousand gallons of water and the weight of coal consumed in performing onemillion foot pounds of work.

   (b) The coefficient of discharge of the pump was determined by two methods, which are as follows:

      Method Number 1.

      The number of strokes of the pump during the test was recorded by a continuous counter. Knowing the piston displacement of the pump, the theoretical discharge can be calculated by multiplying the number of strokes by the displacement. The actual discharge was measured by a tank designed especially for work on this thesis. It was designed by Mr. Mayall working under the supervision of Mr. Seastone, by whom

the apparatus was originated and developed.

The following is a description of the measuring tank taken from The Technograph, Vol. 14.

"It consists essentially of a tank of three compartments with a short wrought-iron vertical discharge-pipe and a glass tube for measuring the velocity head. Fig. 1 shows the longitudinal section, Fig. 2 the plan, and Fig. 3 the end elevation. The water to be measured enters the tank at A, passes downward and through the compartment B, and is discharged through the pipe P. The rectangular opening R in the outflow compartment E terminates in a spout D, which may be detached when desired. The velocity head used is the height to which water rises in the glass tube T. The discharge is computed by the formula $Q=c\,a\sqrt{2gh}$, in which a is the area of the pipe, h the velocity head, and c a co-efficient to be determined by experiment.

"With the apparatus under consideration three sizes of pipe were used,- 2-in., 3-in. and 4-in.diameter. The pipe is ordinary, black pipe, and in each case the actual diameter was 0.1 inch in excess of the nominal size. These pipes are 12 inches long and project 2 inches into compartment B. The ends were planed, the outer edges beveled, and all burs removed from the inner edges. A 6-inch flange-union E with bushings serves as a connection for the different sizes, and the method of their attachment is shown in detail in Fig. 1. The change from one size to another may be quickly made. For satisfactory operation the velocity must be fairly uniformly distributed over the cross-section of the pipe, and this necessitates the use of the baffle

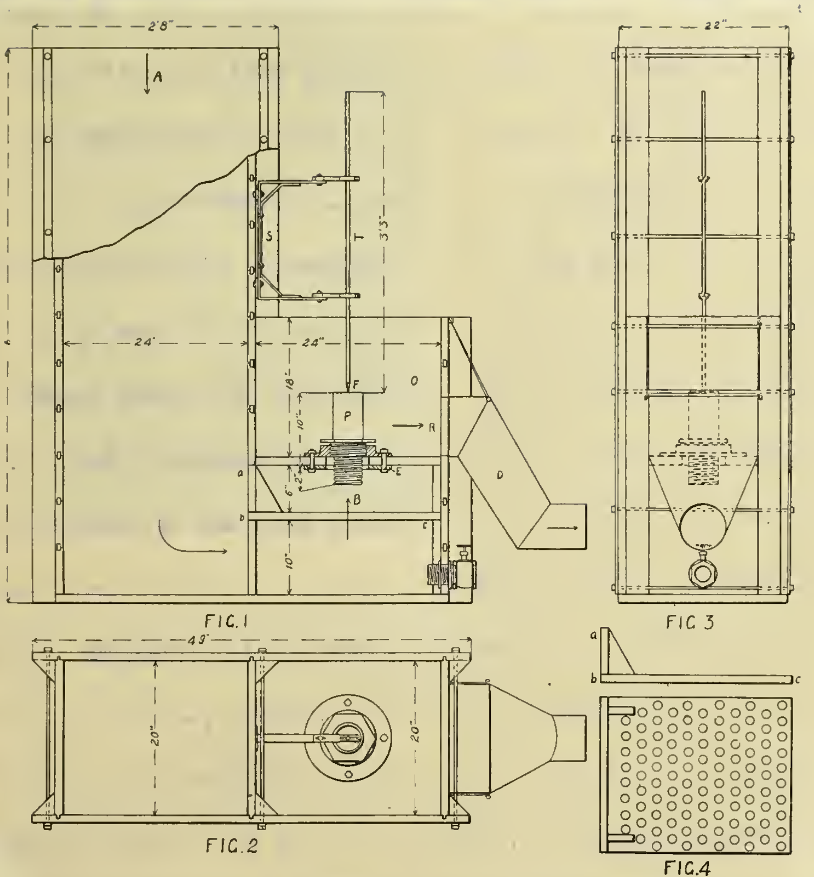

2'8"
A
S
T
3'3"
24"
24"
18"
F
O
10"
P
R
a
2"
E
6"
B
b
c
10"
D
FIG. 1
22"
FIG 3
49"
20"
20"
FIG. 2
a
b
c
FIG. 4

Fig. 1-4.

board a b c. Fig. 4 shows this in detail, the vertical portion a b being solid. The horizontal board is provided with a number of 1-inch openings and serves to distribute the flow fairly uniformily over the compartment B.

"The glass tube T in Fig. 1 has an internal diameter of 0.5-inch, and is provided with a brass tip F. This tip is about 1.5-inches long and the diameter is reduced to 0.19-inch at the end. It has a bore of 0.12-inch, this being made small in order to reduce the fluctuation of the water column in the tube. The tube is graduated to half-tenths of a foot. It is adjusted concentrically and even with the top face of the discharge pipe. The tube is held in place by means of the clamp shown at S, Fig. 1. This arrangement permits a horizontal and vertical adjustment, enabling the tube to be easily set at the proper position.

"Experiments were made to determine the effect of using glass tubes of different sizes. With the conical tip it was .. found not to be necessary to deduct the area of the tube from that of the discharge pipe. The effect of using tubes of different sizes was inappreciable, and it was shown that little errors results from changing the sizes of tube. Without the tip, it was necessary to deduct the area of the tube from that of the discharge pipe in order not to affect the co-efficients.

"The apparatus was calibrated in the Hydraulic Laboratory of the University of Illinois. The source of supply was a standpipe 4 feet in diameter and 60 feet high, which is fed by a 6-inch main from the city water-works. The discharge was meas-

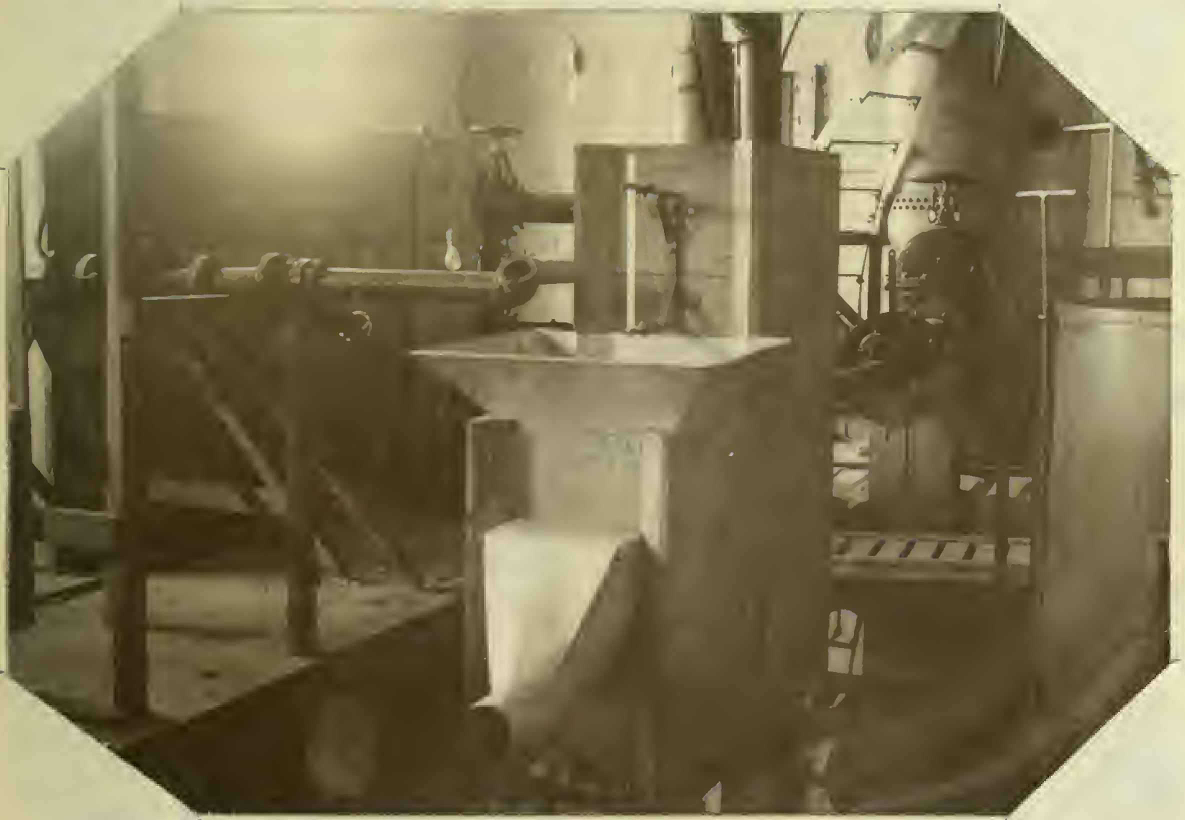
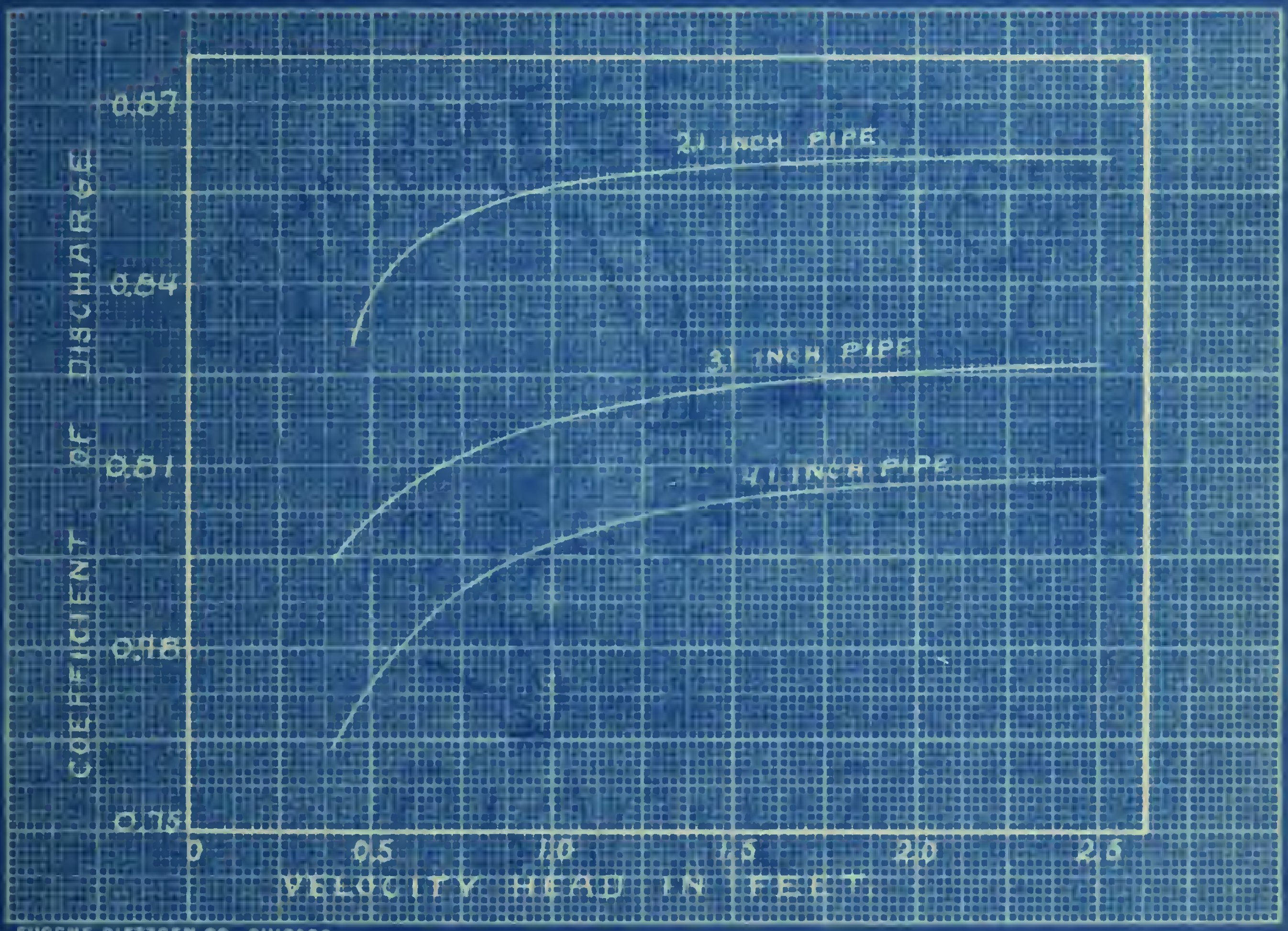


Fig 5 and 6

ured in a pit which has been carefully calibrated. This pit is 25 feet long, 8 feet wide and 3.5 feet deep. A thousandth of a foot rise is equivalent to 0.2064 cubic feet. The rise was measured with a hook gage reading to thousandths of a foot. Each experiment involved a rise in the pit of at least 0.5 feet, thus keeping the error of observation very low. It is fair to assume that the error of measurement did not exceed one quarter of 1 per cent.

"Having adjusted the glass tube to its proper position, the 0 reading of the hook gage in the pit was noted. Water was then admitted to the tank and allowed to run until a fairly uniform flow had been established. During this time the water was carried to a drain through a galvanized iron pipe attached to the spout D. The time was measured by a stop-watch. The height of the water column in the glass tube was recorder at equal intervals of time and the mean of these readings taken as the head. The flow was kept uniform. The fact that the water column stands 3 or 4 inches above the top of the jet, enables its height to be easily observed, and it may be read with an error of less than 0.01 ft.

"The diagram Fig. 7 gives the coefficient of discharge with different velocity heads for the several sizes of pipe. Fig. 8 gives the actual discharge in cubic feet per second for different velocity heads. It will be seen that the form of the curve is essentially the same for the three sizes. The mean error of the co-efficient of discharge for these observations is onequarter of 1 per cent, and the probable error of a single

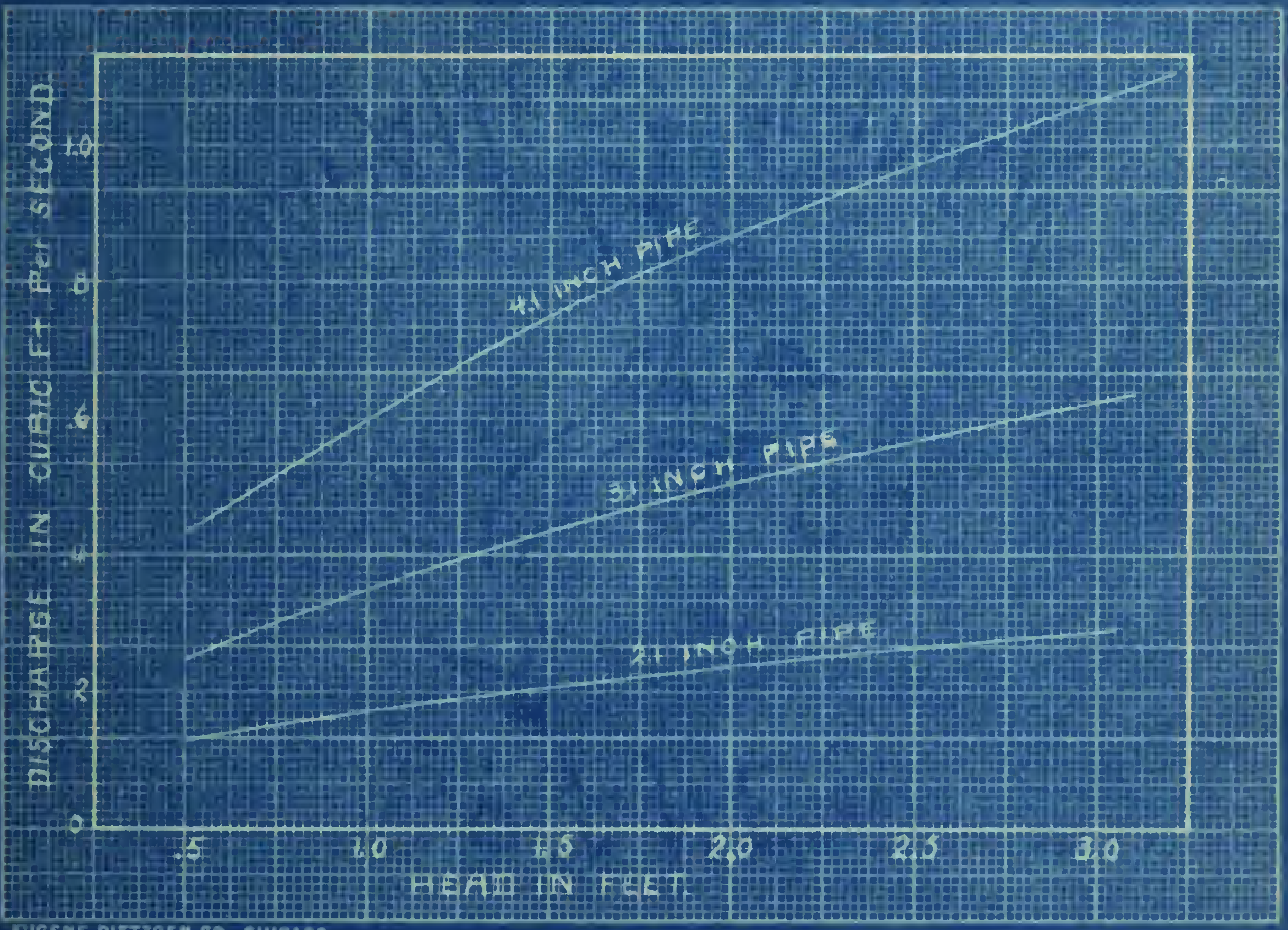


EUGENE DIETZGEN CO., CHICAGO.

FIG. 7.

RELATION BETWEEN THE COEFFICIENT OF DISCARGE AND THE VELOCITY HEAD

THESIS F. J. BIRD.



EUGENE DIETZGEN CO., CHICAGO.

FIG 8
RELATION BETWEEN THE DISCHARGE AND
VELOCITY HEAD

THESIS

F. J. BIRD.

observation one fifth of 1 per cent. It seems fair to assume that the apparatus will measure the discharge with an average error not exceeding one quarter of 1 per cent and a maximum error well within 1 per cent. It should be stated also that it is not best to use heads lower than 0.6 ft., as below this the coefficient drops rapidly and the error of measurement is likely to be greater."

After determining the actual discharge we obtain the coefficient of discharge, which is $= \dfrac{\text{Actual Discharge}}{\text{Theoretical Discharge}}$.

Method Number 2.

The theoretical discharge is measured in the same manner as in method number one.

The actual discharge is measured by making very careful reading of the amount of water pumped into the stand pipe during the test. In doing this the floats on the tank were not relied upon to be correct, but all measurements were taken by letting down a float through the man-hole on the top of the tank.

$$\text{Co-efficient of Discharge} = \frac{\text{Actual Discharge}}{\text{Theoretical Discharge}}.$$

3. Possibility of decreasing the cost of operation.

The tests at the different stations show the condition of the pump.

The cost of operation can be reduced in cases where the pumps are in need of repair or are working under unfavorable conditions.

Since several railroads have found it profitable to change from a steam pump to a pump driven by a gasoline engine, at each station this question was investigated and the following points noted.

(a) Distance of pump house from depot.

(b) Amount of water pumped per day.

(c) Present duties of pumpman in addition to attending to the pump.

(d) Size of town and duties of Station Agent.

(e) Cost of pumping by gasoline.

—— . —— . —— . —— . —— . —— . ——

Where neither of two stations which are near together provides enough work for one man, the cost of operation can be reduced by having one attendant for both pumps. In some cases this may require the installation of a pump of greater capacity, but the decrease in the cost of operation might warrant the change.

### 4. Chemical Analysis.

The water was collected in the majority of cases at the different stations in gallon jugs glazed both inside and out. This would insure the water against materials that might collect on an unglazed jug. The time of the year at the time of collection was noted as was also the condition of the well as regards surface water. All water was collected from either suction or discharge and all jugs were thoroughly washed with same water before being filled.

Duplicate analysis of each water were made. Professor Parr or his assistant Mr. F. Koch also checked the result

by a third analysis.

Following is a description of the methods used in the analysis.

For determining the following:

$SiO_2$, $Fe_2O_3 + Al_2O_3$, CaO and MgO.

Acidified 500 c.c. of water with HCl, evaporated to dryness and baked. Dissolved in water + HCl, filtered and washed with water containing HCl.

| | |
|---|---|
| I. P'p't. $SiO_2$ | I. Solution. |
| Ignited and weighed. Added HF, again ignited and weighed. Loss = $SiO_2$. | Heated to boiling and added $NH_4OH$ in slight excess. Filtered and washed. |
| II. P'p't. $Fe(OH)_3$ + $Al(OH)_3$ | II. Solution. |
| Ignited and weighed as $Fe_2O_3 + Al_2O_3$. | Added $(NH_4)_2C_2O_4$ to the boiling solution. Filtered and washed thoroughly. |
| III. P'p't. $CaC_2O_4$ | III. Solution. |
| Dissolved in hot dilute $H_2SO_4$ and titrated with standard $KMnO_4$ solution. | Concentrated the solution III, cooled and added $NH_4NaHPO_4$ with large excess of $NH_4OH$. Filtered and washed. |
| IV. P'p't. $NH_4MgPO_4$ | |
| Ignited and weighed as $Mg_2P_2O_7$. | |

For Determining the Alkalies and Sulphate.

Acidified 500 c.c. of the water with HCl, evaporated to dryness and baked. Dissolved in water + HCl, filtered and washed.

| | |
|---|---|
| I. P'p't. $SiO_2$ | I. Solution. |
| Disregarded. | Added 10 c.c. $BaCl_2$ sal. (10 %) to the boiling solution. Filtered and washed. |
| II. P'p't. $BaSO_4$ | II. Solution. |
| Ignited and weighed. | Concentrated and added alkali free $Ba(OH)_2$ in excess. Filtered and washed. |
| III. P'p't. $Mg(OH)_2$ | III. Solution. |
| Disregarded. | Added $(NH_4)_2CO_3$ and concentrated. Filtered and washed. Repeated this treatment until no more p'p't. was obtained. Evaporated to dryness in platinum dish, baked and weighed as NaCl. |

# PEKIN, ILLINOIS.

# WATER STATION ON THE PEORIA AND EASTERN RAILWAY.

# PEKIN, ILLINOIS.

## DATA RELATING TO INSPECTION PLANT.

| | |
|---|---|
| Date of Installation | 1880. |
| Date of Inspection | Dec. 21, 1899. |
| Date of Test | Jan. 5, 1901. |
| Make of Pump | F. M. & Co. |
| Size of Pump - Double Acting | 6" x 5 3/4" x 10. |
| Additional duties of pumpman | Pumps at Mackinaw. |
| Number of hours per day pump is in operation | 3. |
| Height of Suction | 20 ft. |
| Height of Discharge | 48 ft. |
| Size of Tank | 30' x 20'. |

# # # # # # # # # # #

## PEKIN, ILLINOIS.

### DATA RELATING TO THE CO-EFFICIENT OF DISCHARGE TEST.

| | |
|---|---|
| Method Number | 2. |
| Average boiler pressure | 72 lbs. |
| Average pressure head on pump | 21 lbs. |
| Average number of strokes per min. | 57. |
| Pistón speed ft. per min. | 95. |
| Duration of test | 1 hr. 9 min. |
| Theoretical discharge during test | 8803 gals. |
| Actual discharge during test | 7446 gals. |
| Co-efficient of discharge | 84.6 % |
| Theoretical discharge per hour | 7654 gals. |
| Actual discharge per hour | 6474 gals. |

# # # # # # # # # # #

## PEKIN, ILLINOIS.

### DATA RELATING TO THE EFFICIENCY TEST.

| | |
|---|---|
| Duration of test | 2 hr. 40 min. |
| Actual amount of water pumped during test | 17031 gals. |
| Amount of coal burned during test | 215 lbs. |
| Water evaporated in boiler during test | 834 lbs. |
| Water evaporated per pound of coal | 3.88 lbs. |
| Coal consumed in pumping 1000 gals. of water | 12.7 lbs. |
| Work performed per pound of coal | 31780 ft. lbs. |

# # # # # # # # # # #

### RESULTS OF TESTS AND INSPECTION.

| | |
|---|---|
| Water pumped per day | 20000 gals. |
| Work performed per day in lifting water | 8020800 ft. lbs. |
| Work obtained from one pound of coal | 31780 ft. lbs. |
| Coal consumed per 24hrs. | 252 lbs. |
| Coal consumed per 1000 gals. of water pumped | 12.6 lbs. |
| Coal consumed per month | 7560 lbs. |

# # # # # # # # # # #

## PEKIN, ILLINOIS.

### RESULTS OF ESTIMATES ON COSTS.

| | |
|---|---|
| Cost of plant complete | $5150.00 |
| Cost of repairs per month at 2 % per year | 8.58 |
| Amount of depreciation of plant per month @ 5 % per year | 21.45 |
| Interest per month at rate of 5 % per year | 21.45 |
| Cost of labor per month | 17.50 |
| Cost of supplies per month | 5.00 |
| Cost of coal per month @ $1.10 per ton | 4.15 |
| Total cost of pumping per month | 78.13 |
| Total cost of pumping 1000 gallons | .130 |
| Total cost of pumping per month including treatment with soda ash | 91.57 |
| Cost of coal per 1000 gals. of water pumped | .0069 |

# # # # # # # # # # #

## PEKIN, ILLINOIS.

### RESULTS OF CHEMICAL ANALYSIS.

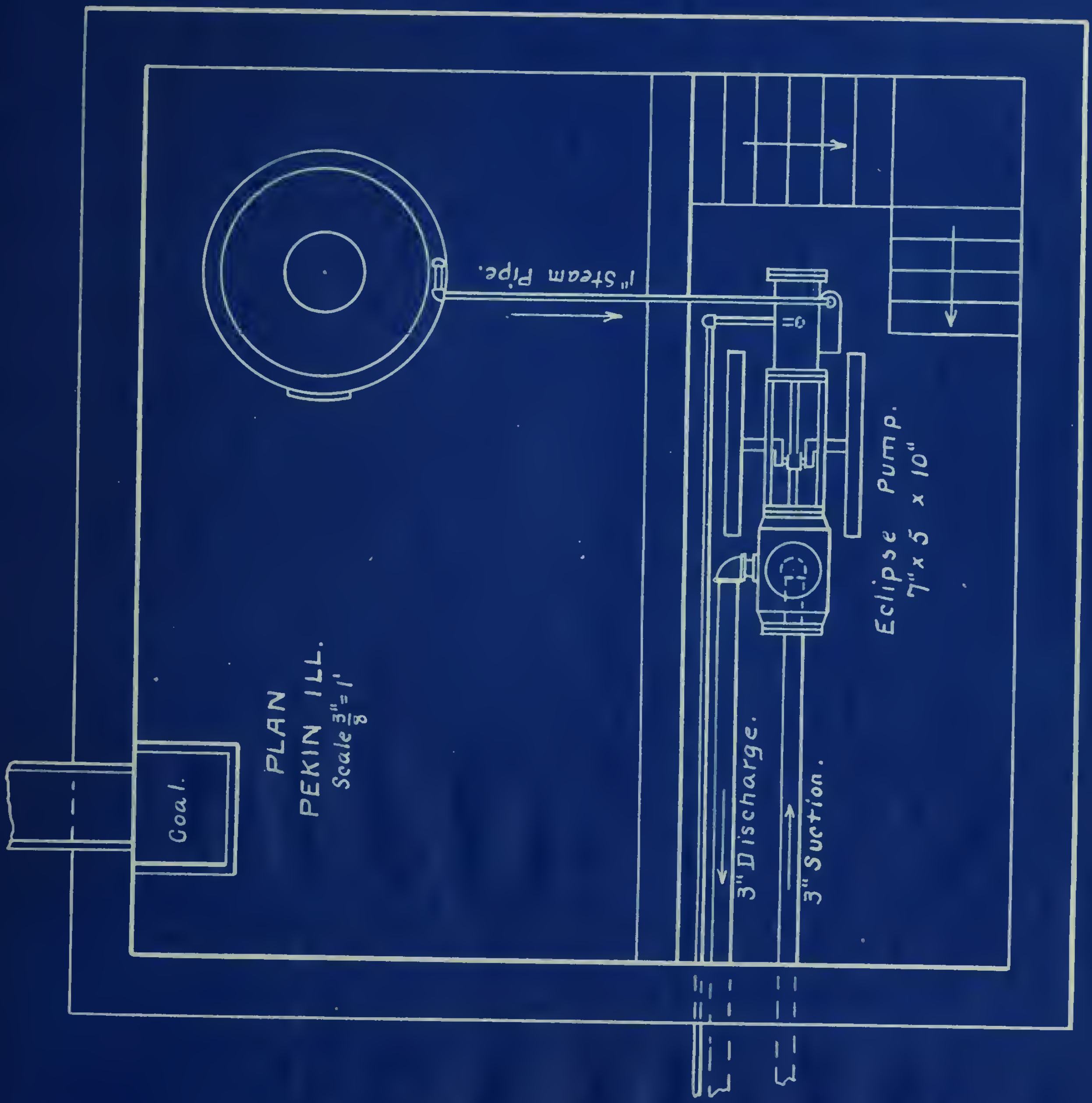
| | |
|---|---|
| Soda ash required for each 1000 gals. of water | 1.15 lbs. |
| Soda ash required for each hour pump is in operation | 7.47 lbs. |
| Soda ash required per day | 22.41 lbs. |
| Soda ash required per month | 672.3 lbs. |
| Cost per month for treatment with soda ash @ 2¢ per pound | $13.44 |

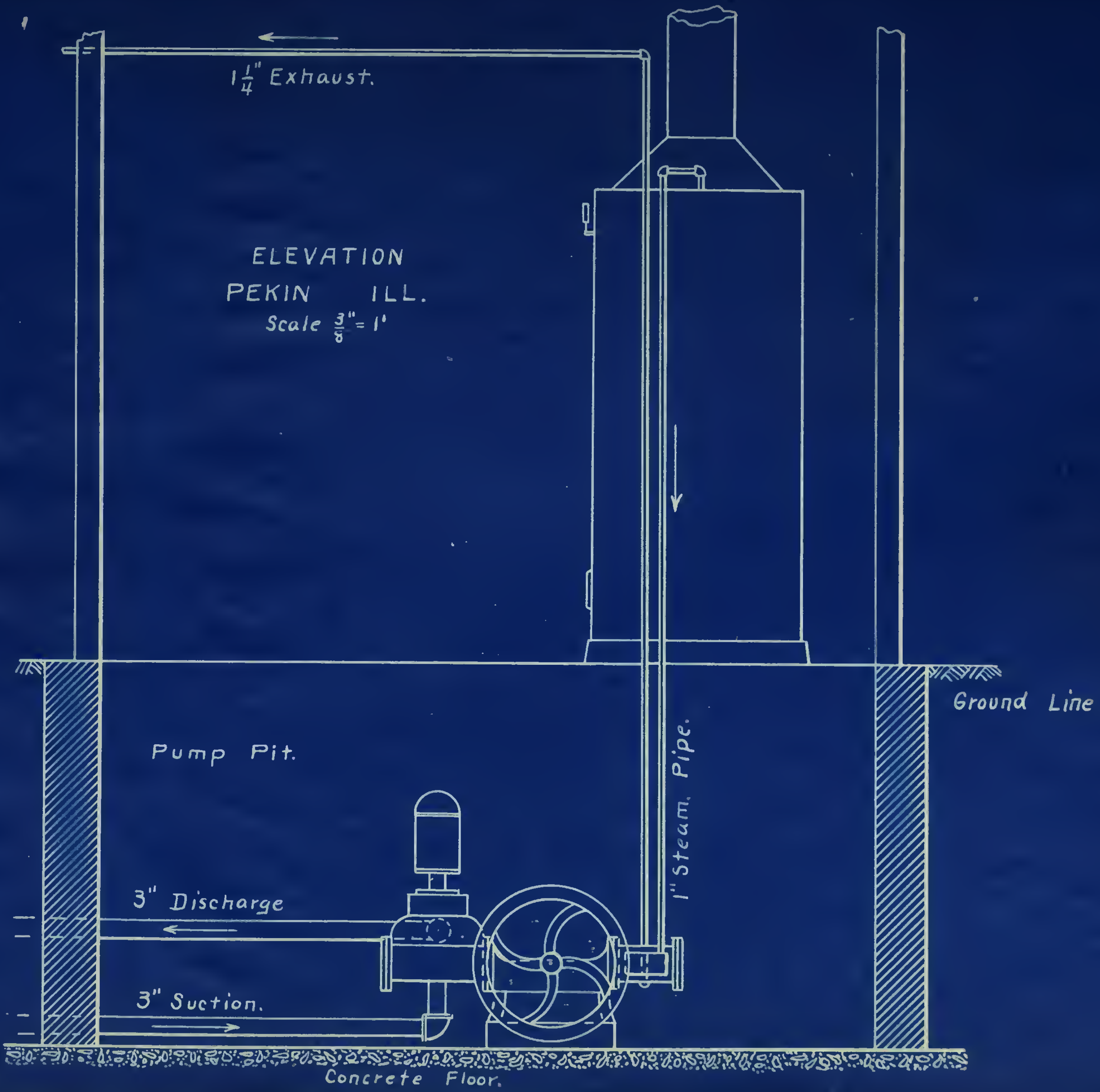
###########

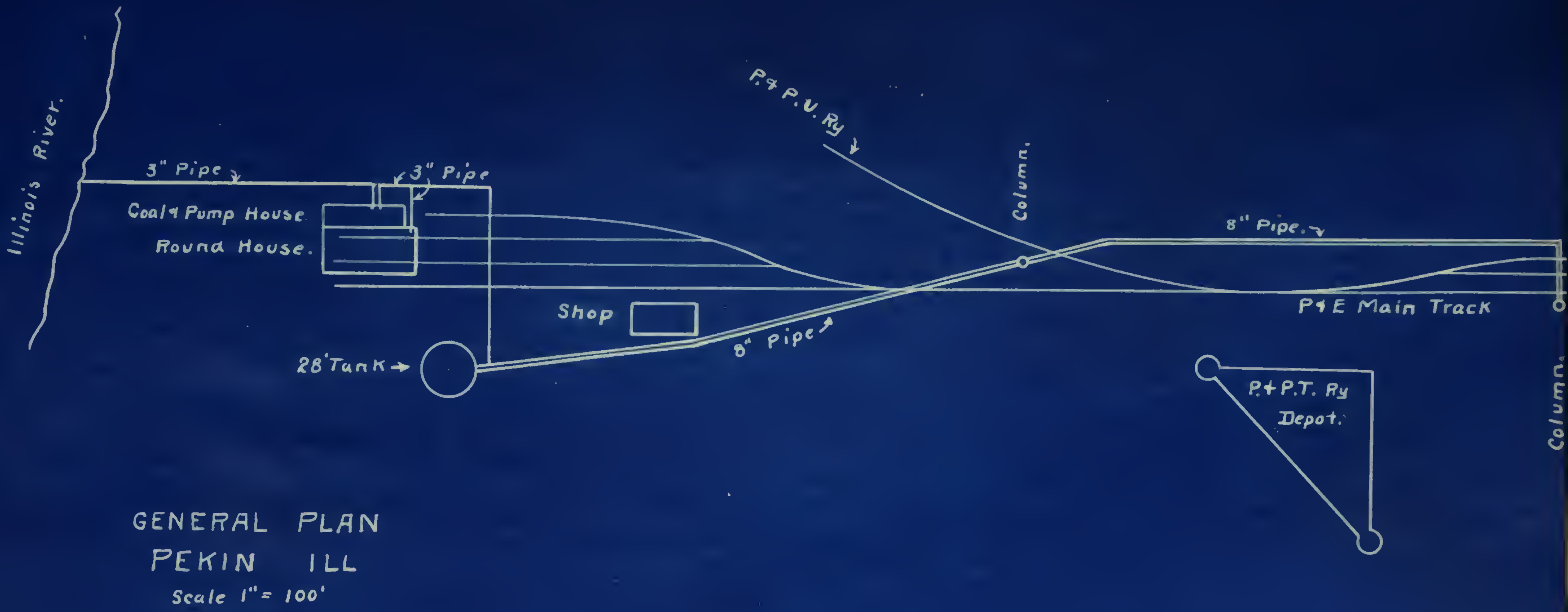
### REMARKS.

Pumpman also does the pumping at Mackinaw. The water is taken from the Illinois River and will form a slight scale.

###########


PLAN
PEKIN ILL.
Scale 3/8" = 1'
Coal.
1" Steam Pipe.
Eclipse Pump.
7" x 5 x 10"
3" Discharge.
3" Suction.


1¼" Exhaust.
ELEVATION
PEKIN ILL.
Scale 3/8" = 1'
Ground Line
Pump Pit.
1" Steam. Pipe.
3" Discharge
3" Suction.
Concrete Floor.



GENERAL PLAN
PEKIN ILL
Scale 1" = 100'

Illinois River.
3" Pipe
3" Pipe
Coal & Pump House
Round House.
P. & P.U. Ry
Column.
8" Pipe.
Shop
8" Pipe
28' Tank
P & E Main Track
P. & P.T. Ry
Depot.
Column.

Pekin.

# MACKINAW, ILLINOIS.

# WATER STATION ON THE PEORIA AND EASTERN RAILWAY.

# MACKINAW, ILLINOIS.

## DATA FROM INSPECTION OF PLANT.

| | |
|---|---|
| Date of Installation | 1895. |
| Date of Inspection | Dec. 21, 1899. |
| Date of Test | Jan. 7, 1901. |
| Make of Pump | Cook. |
| Size of Pump | 9" x 5 1/2" x 36". |
| Number of Hours per day Pump is in Operation | 4. |
| Depth of Well | 210 ft. |
| Height of Discharge - i.e.- From top of water in well to top of tank | 105 ft. |
| Size of Tank | 24' x 16'. |

# # # # # # # # # # #

## MACKINAW, ILLINOIS.

### DATA RELATING TO THE EFFICIENCY TEST.

| | |
|---|---|
| Duration of Test | 3 hrs.19 min. |
| Actual quantity of water pumped during test | 17314 gals. |
| Coal burned during test | 305 lbs. |
| Water evaporated during test | 1160 lbs. |
| Water evaporated per pound of coal | 3.83 lbs. |
| Coal consumed in pumping 1000 gallons | 17.6 lbs. |
| Work performed per pound of coal | 49780 ft. lbs. |

# # # # # # # # # # #

# MACKINAW, ILLINOIS.

## DATA RELATING TO THE CO-EFFICIENT OF DISCHARGE TEST.

| Test Number | 1. | 2. |
|---|---|---|
| Method Number | 2. | 2. |
| Average boiler pressure | 90 lbs. | 88 lbs. |
| Average pressure head on pump | 15 lbs. | 15 lbs. |
| Average number of strokes per min. | 25. | 25. |
| Piston speed ft. per min. | 150. | 150. |
| Duration of test | 1 hr. | 1 hr. |
| Theoretical discharge per hour | 5600 gals. | 5543 gals. |
| Actual discharge per hour | 5331 gals. | 5223 gals. |
| Co-efficient of discharge | 95.2 % | 94.2 % |

############

| | |
|---|---|
| Average discharge per hour | 5277 gals. |
| Average co-efficient of discharge | 94.7 |

## MACKINAW, ILLINOIS.

### RESULTS OF TESTS AND INSPECTION.

| | |
|---|---|
| Water pumped per day | 21108 gals. |
| Work performed per day in lifting water | 18657195 ft. lbs. |
| Work performed from one pound of coal | 49780 ft. lbs. |
| Coal consumed per day | 374 lbs. |
| Coal consumed per 1000 gallons of water pumped | 17.6 lbs. |
| Coal consumed per month | 11220 lbs. |

# # # # # # # # # # #

## MACKINAW, ILLINOIS.

### RESULTS OF ESTIMATES ON COSTS.

| | |
|---|---|
| Cost of plant complete | $7097.00 |
| Cost of repairs per month @ rate of 2 % per year | 11.82 |
| Amount of depreciation of plant per month @ rate of 5 % per year | 29.57 |
| Interest per month at rate of 5 % per year | 29.57 |
| Cost of labor per month | 17.50 |
| Cost of supplies per month | 5.00 |
| Cost of coal per month @ $1.10 per ton | 6.17 |
| Total cost of pumping per month | 99.63 |
| Total cost of pumping 1000 gallons | .157 |
| Cost of coal burned per 1000 gallons of water pumped | .009 |

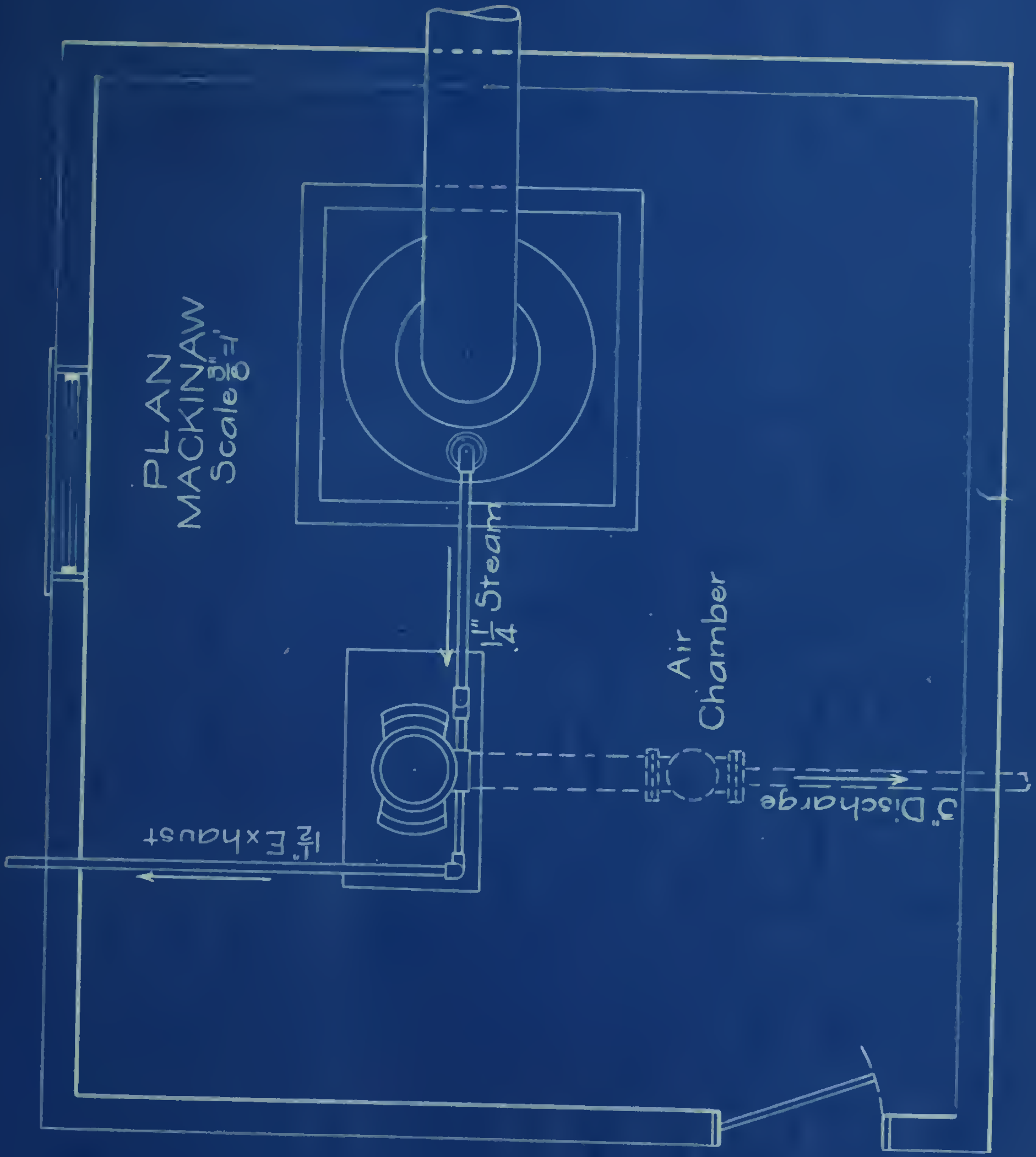
# # # # # # # # # # #

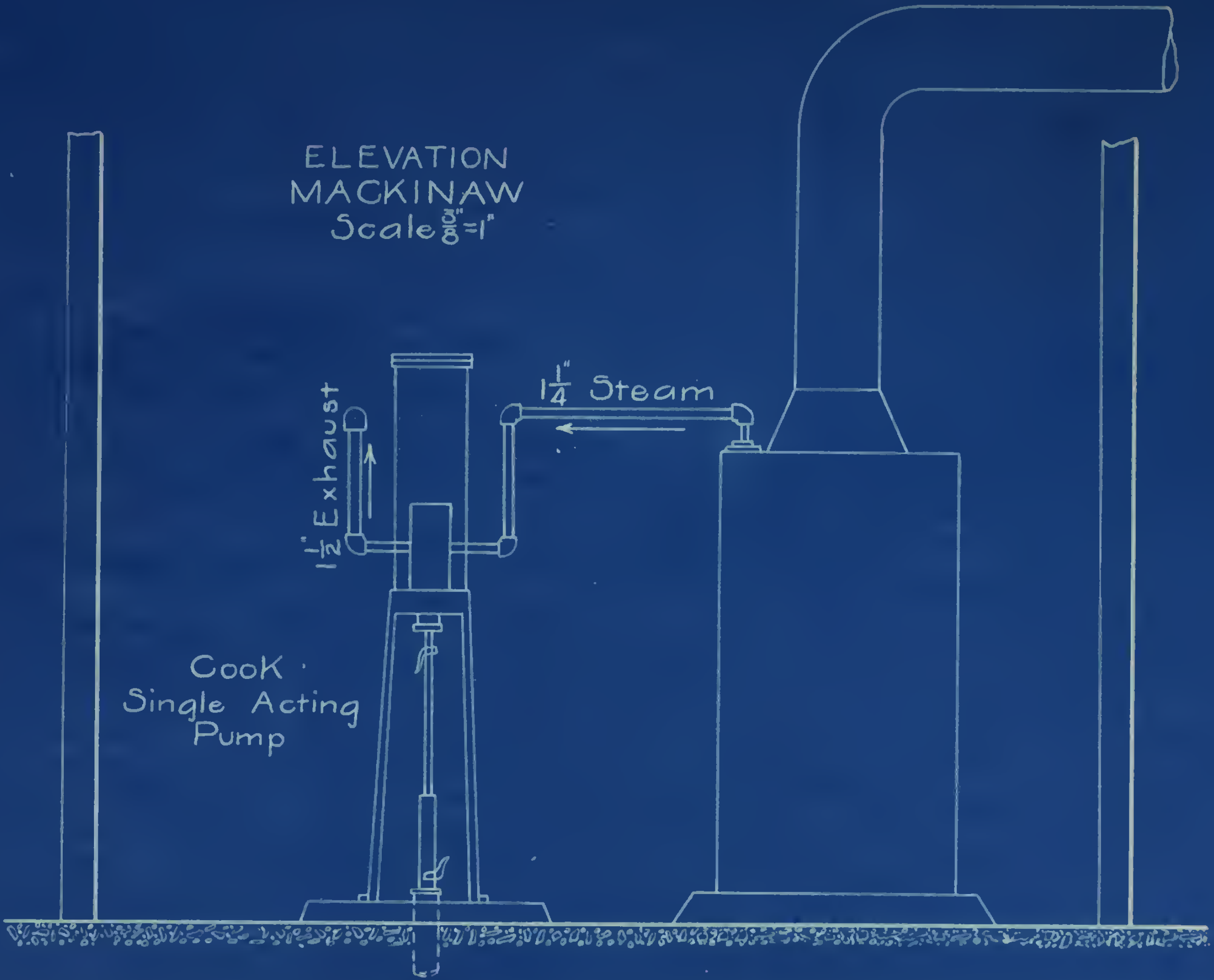
## MACKINAW, ILLINOIS.

### REMARKS.

The water here is fair; no scale forms. The co-efficient of discharge is exceptionally high and the pump is in very good condition. A higher steam pressure was carried than at other stations.

# # # # # # # # # # #

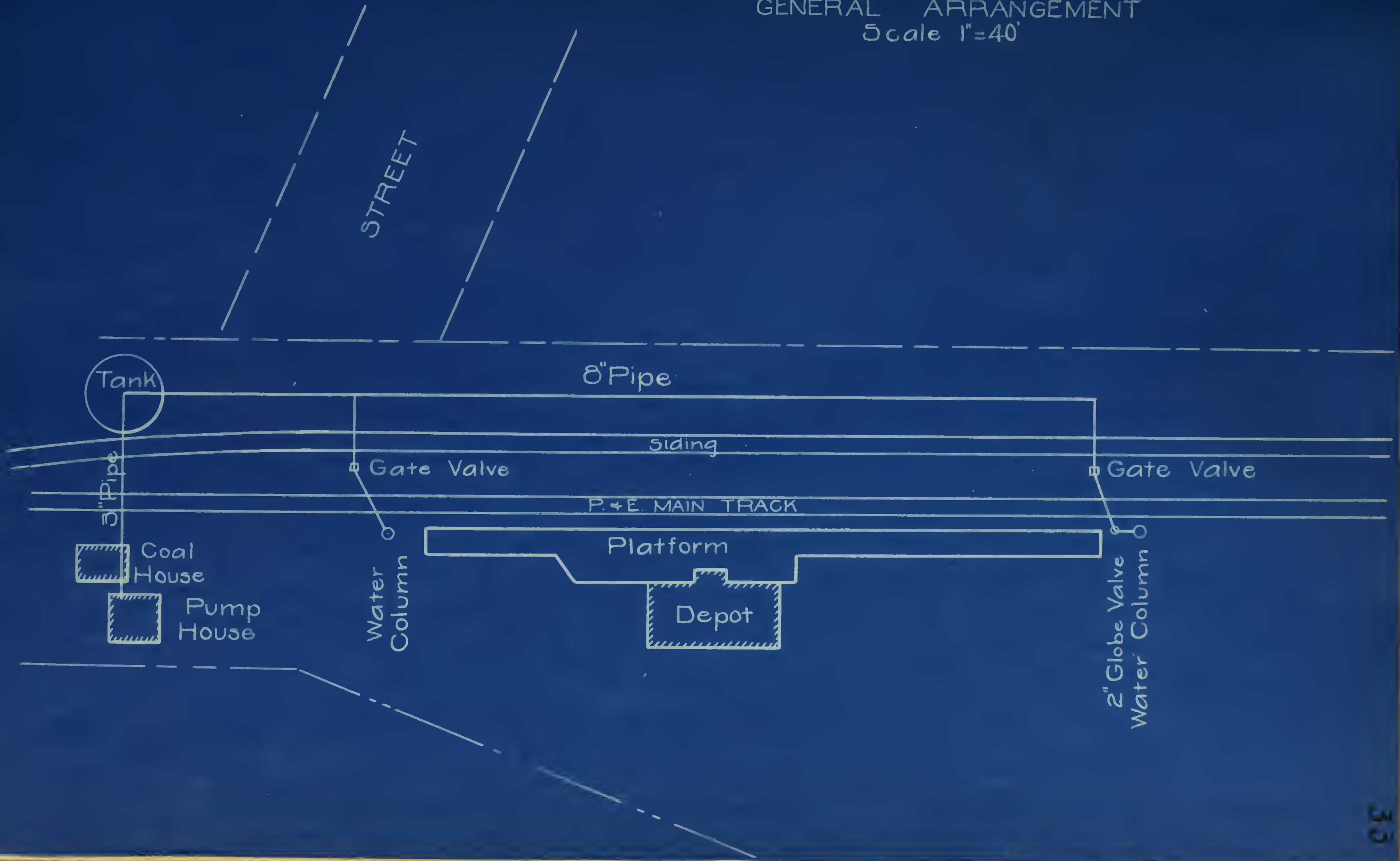

PLAN
MACKINAW
Scale 3/8"=1'
1¼" Steam
Air Chamber
3" Discharge
1½" Exhaust



ELEVATION
MACKINAW
Scale $\frac{3}{8}$" = 1"

$1\frac{1}{4}$" Steam
$1\frac{1}{2}$" Exhaust
Cook
Single Acting
Pump

# MACKINAW
# GENERAL ARRANGEMENT
Scale 1"=40'


STREET
Tank
8"Pipe
Siding
Gate Valve
Gate Valve
P. & E. MAIN TRACK
3"Pipe
Coal House
Pump House
Water Column
Platform
Depot
2" Globe Valve
Water Column

Mackinaw.

# BLOOMINGTON, ILLINOIS.

## WATER STATION ON THE PEORIA
## AND EASTERN RAILWAY.

## BLOOMINGTON, ILLINOIS.

### DATA FROM INSPECTION OF PLANT.

| | |
|---|---|
| Date of Installation | 1886. |
| Date of inspection | Dec. 22, 1899. |
| Date of Test | May 17, 1900. |
| Make of Pump | Cook. |
| Size of Pump | 10" x 9 1/2" x 36". |
| Number of hours per day pump is in operation | 10. |
| Depth of Well | 165 ft. |
| Height of Discharge (From surface of water in well to top of tank) | 99 ft. |
| Size of East Tank | 18' x 16'. |
| Size of West Tank | 15' x 16'. |

# # # # # # # # # # #

## BLOOMININGTON, ILLINOIS.

### RESULTS OF TESTS AND INSPECTION.

| | |
|---|---|
| Water pumped per day | 88050 gals. |
| Work performed per day in lifting water | 72828360 ft. lbs. |
| Work performed from one pound of coal (Mackinaw Test) | 49780 ft. lbs. |
| Coal consumed per day | 1463 lbs. |
| Coal consumed per 1000 gallons of water pumped | 16.6 lbs. |
| Coal consumed per month | 43890 lbs. |

# # # # # # # # # # #

### REMARKS.

The water at this station is very good. There is quite a quantity of natural gas that is free in the water which may account for the small co-efficient of discharge.

# # # # # # # # # # #

## BLOOMINGTON, ILLINOIS.

### DATA RELATING TO THE CO-EFFICIENT OF DISCHARGE TEST.

| | | | |
|---|---|---|---|
| Test Number | 1. | 2. | 3. |
| Method Number | 1. | 1. | 1. |
| Average boiler pressure | 60.9 lbs. | 61.7 lbs. | 61.9 lbs. |
| Average no. of strokes per min. | 14. | 16. | 17.8 |
| Piston speed ft. per min. | 84. | 96. | 106. |
| Theoretical discharge per hour | 9265 gals. | 10588 gals. | 11779 gals. |
| Actual discharge per hour | 7485 gals. | 8805 ~~8015~~ gals. | 10179 gals. |
| Co-efficient of discharge | 80.8 % | 83.1 % | 86.4 % |

# # # # # # # # # # #

## BLOOMINGTON, ILLINOIS.

### RESULTS OF ESTIMATES ON COSTS.

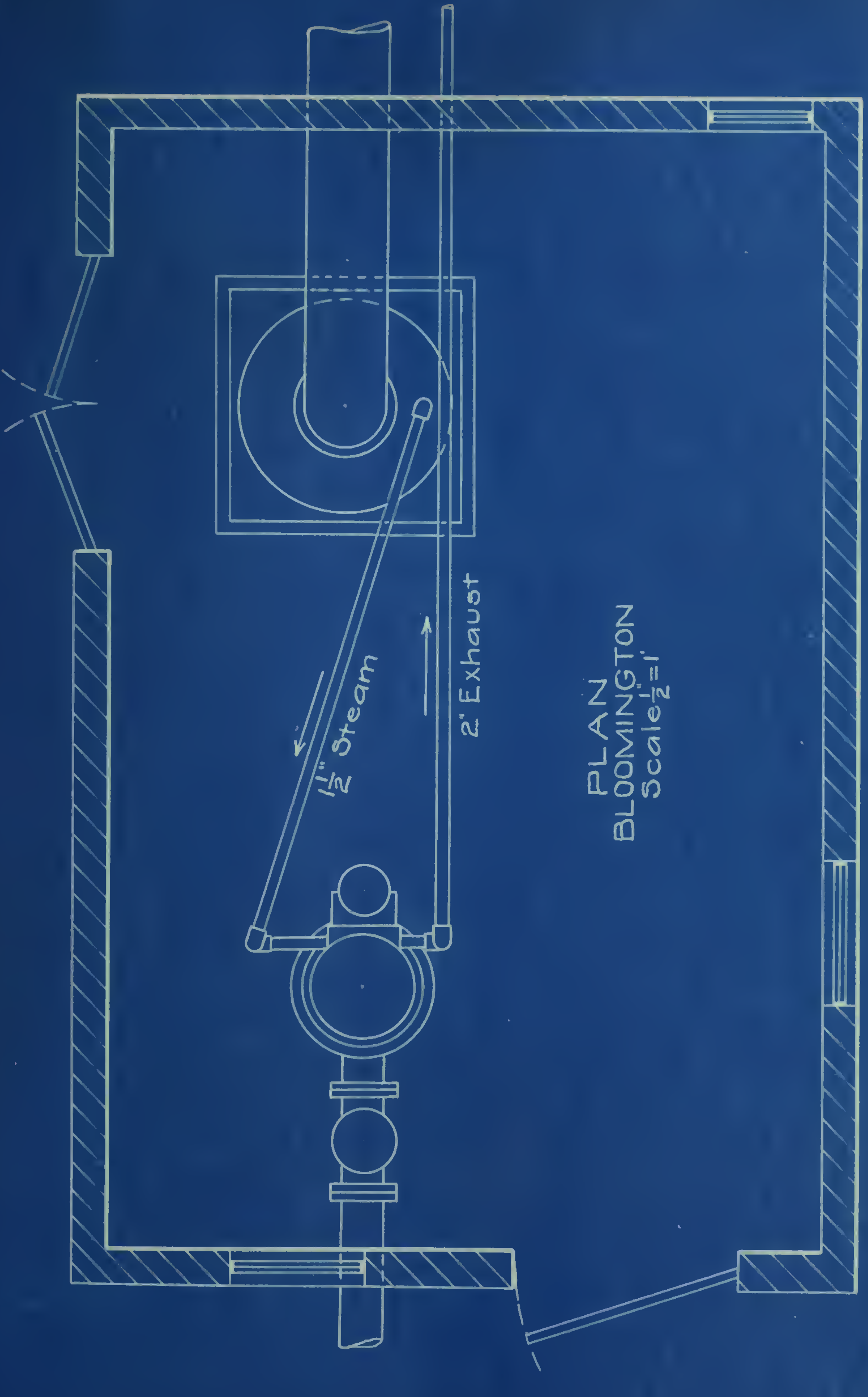
| | |
|---|---|
| Cost of plant complete | $5640.00 |
| Cost of repairs per month at rate of 2 % per year | 9.40 |
| Amount of depreciation of plant per month at 5 % per year | 23.50 |
| Interest on investment per month at rate of 5 % per year | 23.50 |
| Cost of labor per month | 15.00 |
| Cost of supplies per month | 5.00 |
| Cost of coal per month at $1.10 per ton | 24.13 |
| Total cost of pumping per month | 100.53 |
| Total cost of pumping 1000 gallons | .037 |
| Cost of coal consumed in pumping 1000 gallons | .0091 |

# # # # # # # # # #

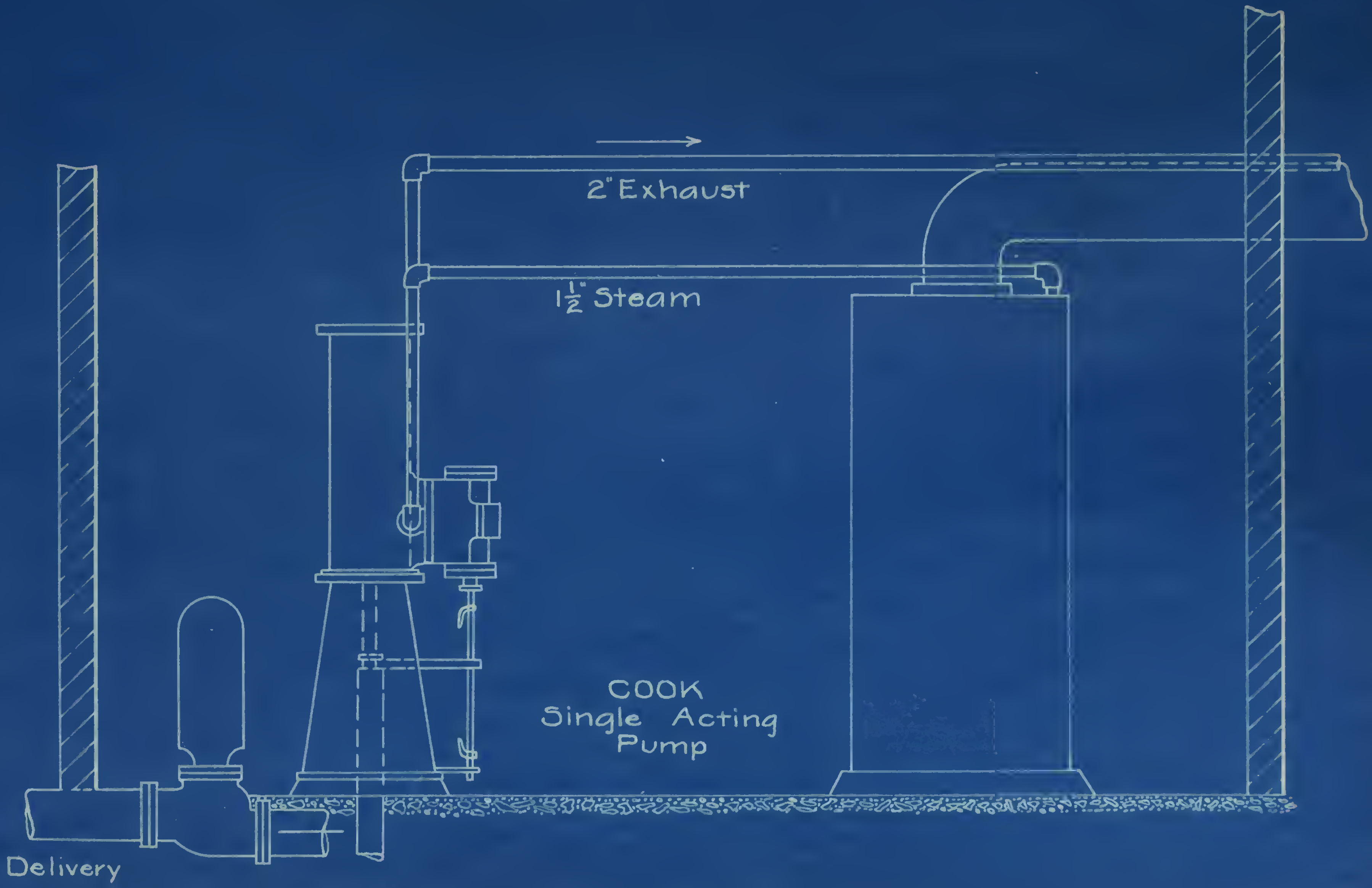
HDR
OP!

Bloomington.

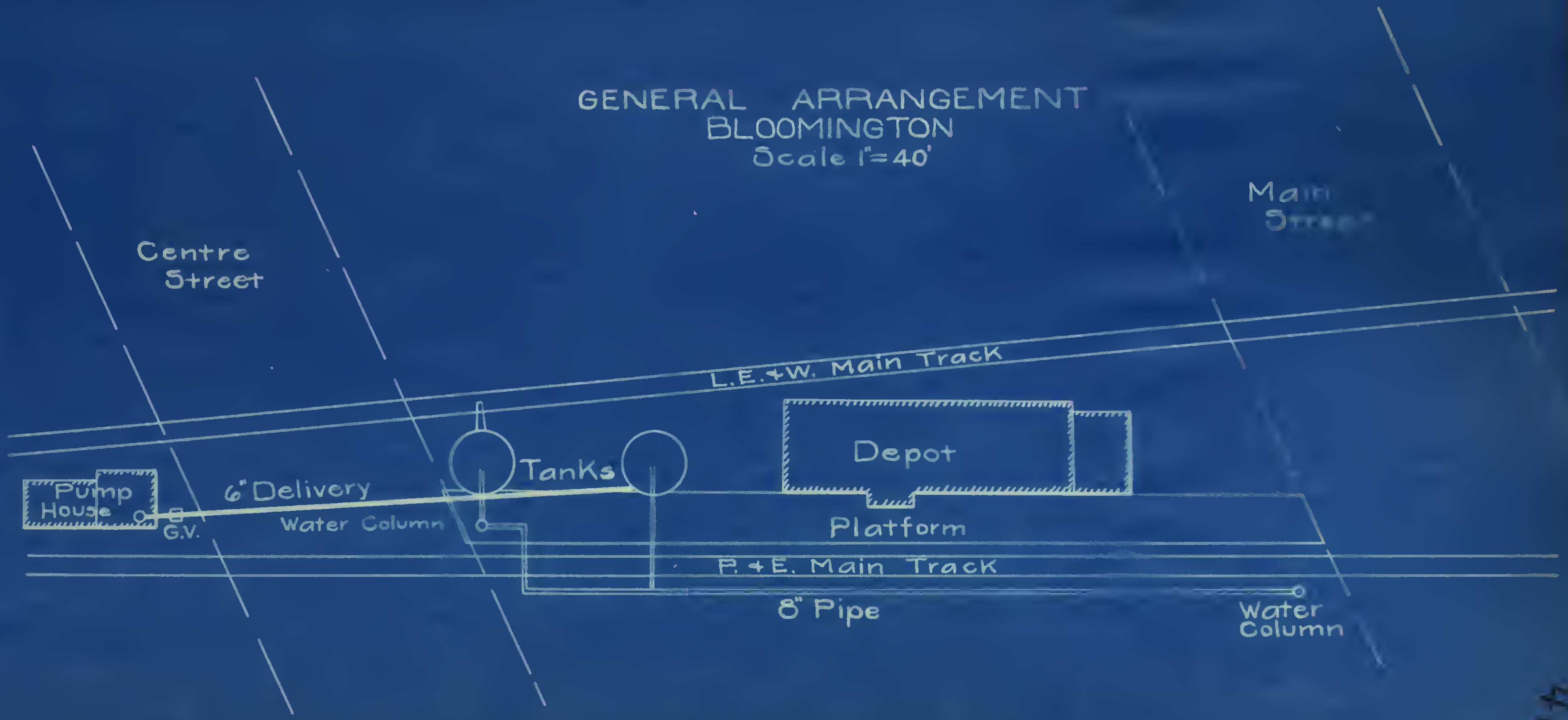
Bloomington.


1½" Steam
2' Exhaust

PLAN
BLOOMINGTON
Scale ½"=1'


2" Exhaust
1½" Steam
COOK
Single Acting
Pump
Delivery

GENERAL ARRANGEMENT
BLOOMINGTON
Scale 1"=40'


Main Street
Centre Street
L.E.+W. Main Track
Depot
Tanks
Pump House
G.V.
6" Delivery
Water Column
Platform
P.+E. Main Track
8" Pipe
Water Column

# MAHOMET, ILLINOIS.

# WATER STATION ON THE PEORIA AND EASTERN RAILWAY.

# MAHOMET, ILLINOIS.

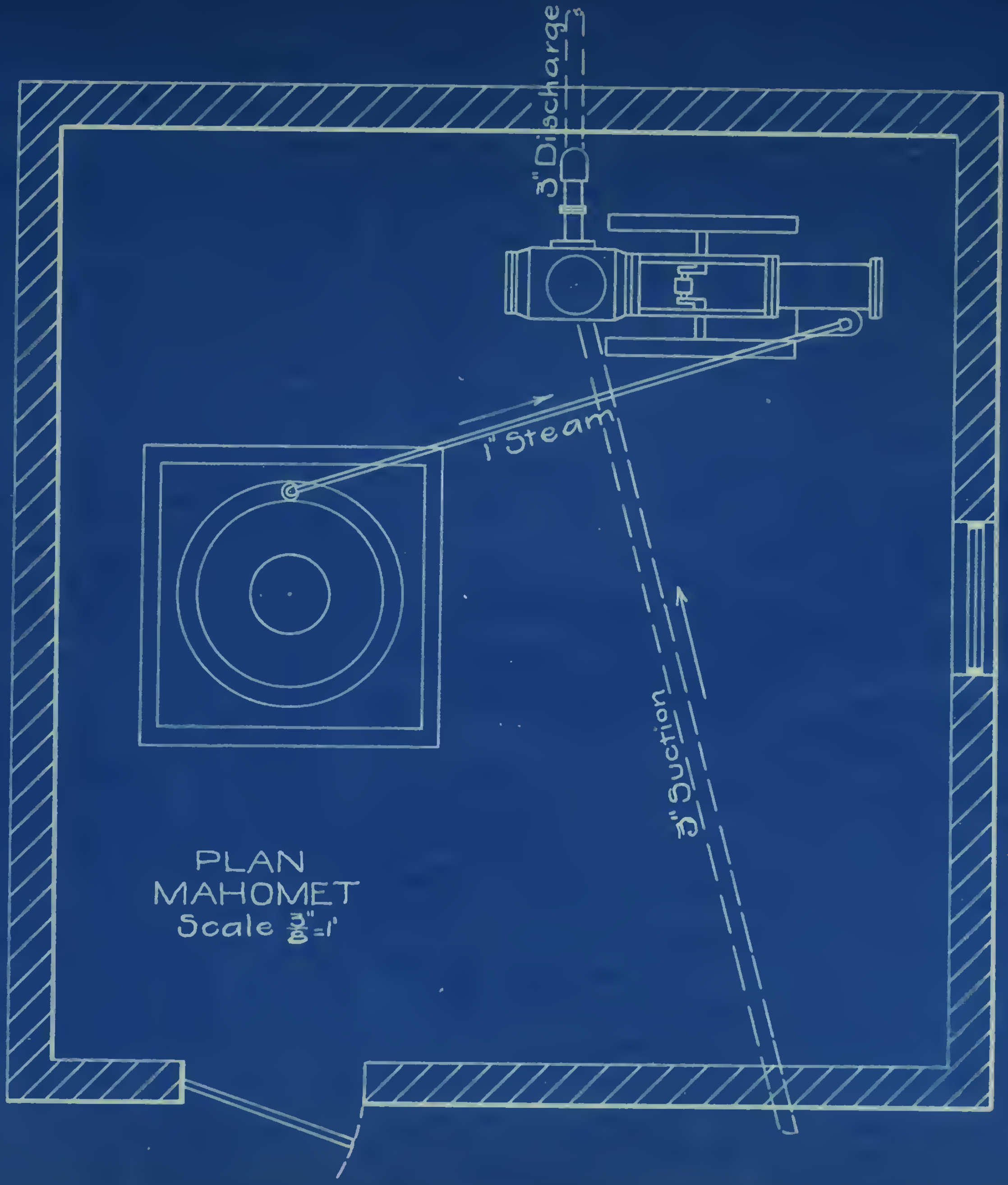
## DATA RELATING TO INSPECTION PLANT.

| | |
|---|---|
| Date of Installation | 1896. |
| Date of Inspection | Dec. 23, 1899. |
| Make of Pump | F. M. & Co. |
| Size of Pump | 6" x 5" x 10". |
| Distance of pump house from depot | 780 ft. |
| Number of hours per day pump is in operation | 2 1/2. |
| Size of Tank | 24' x 16'. |

# # # # # # # # # # #

## REMARKS.

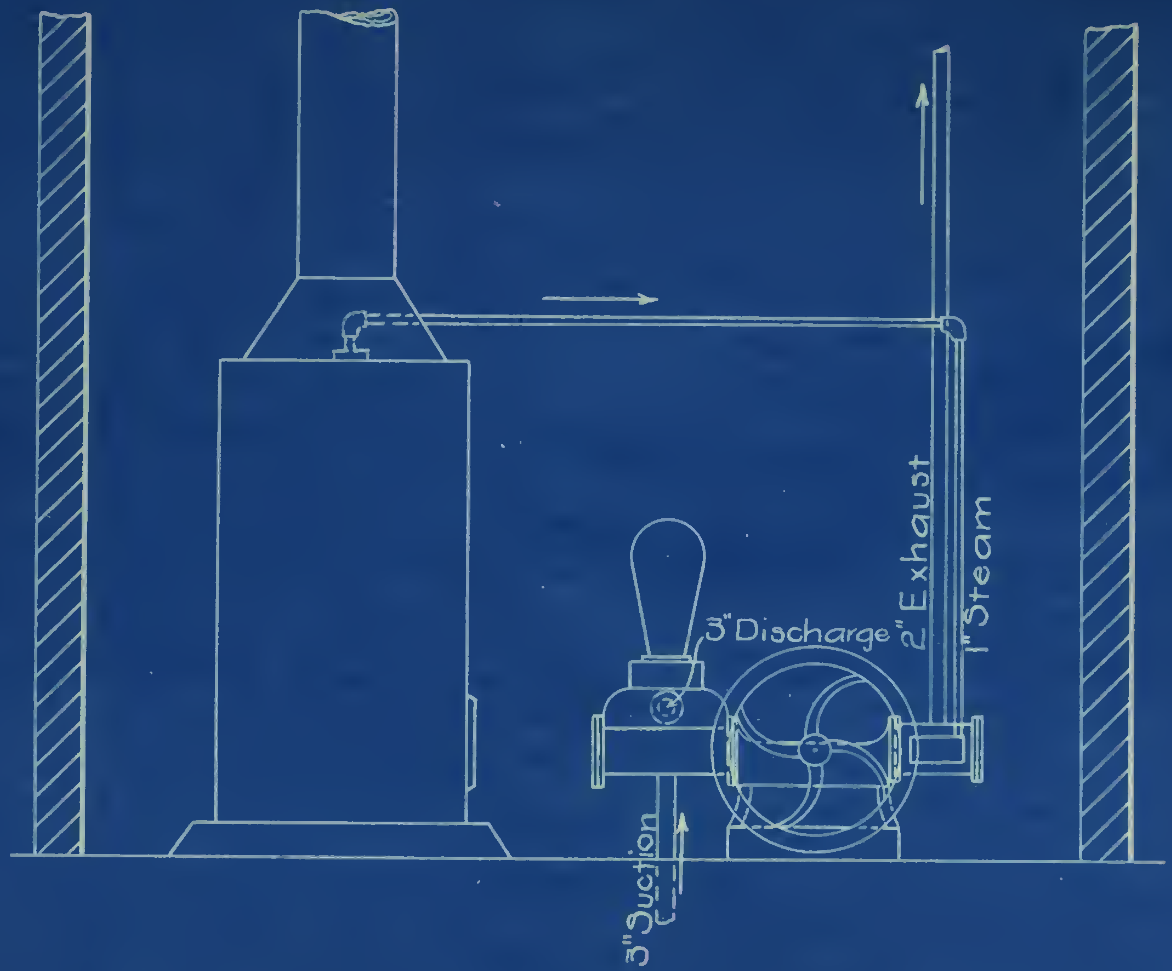
The distance of pump house from the station makes it impracticable to use a gasoline engine. As this pump is only in operation about two and one half to three hours a day it would seem advisable for the pumpman at Muncie to do the pumping at this station. For some reason height of discharge was not obtained on inspection trip, and as the pump was not tested it is impossible to make estimates on amount of coal used on cost of operation.



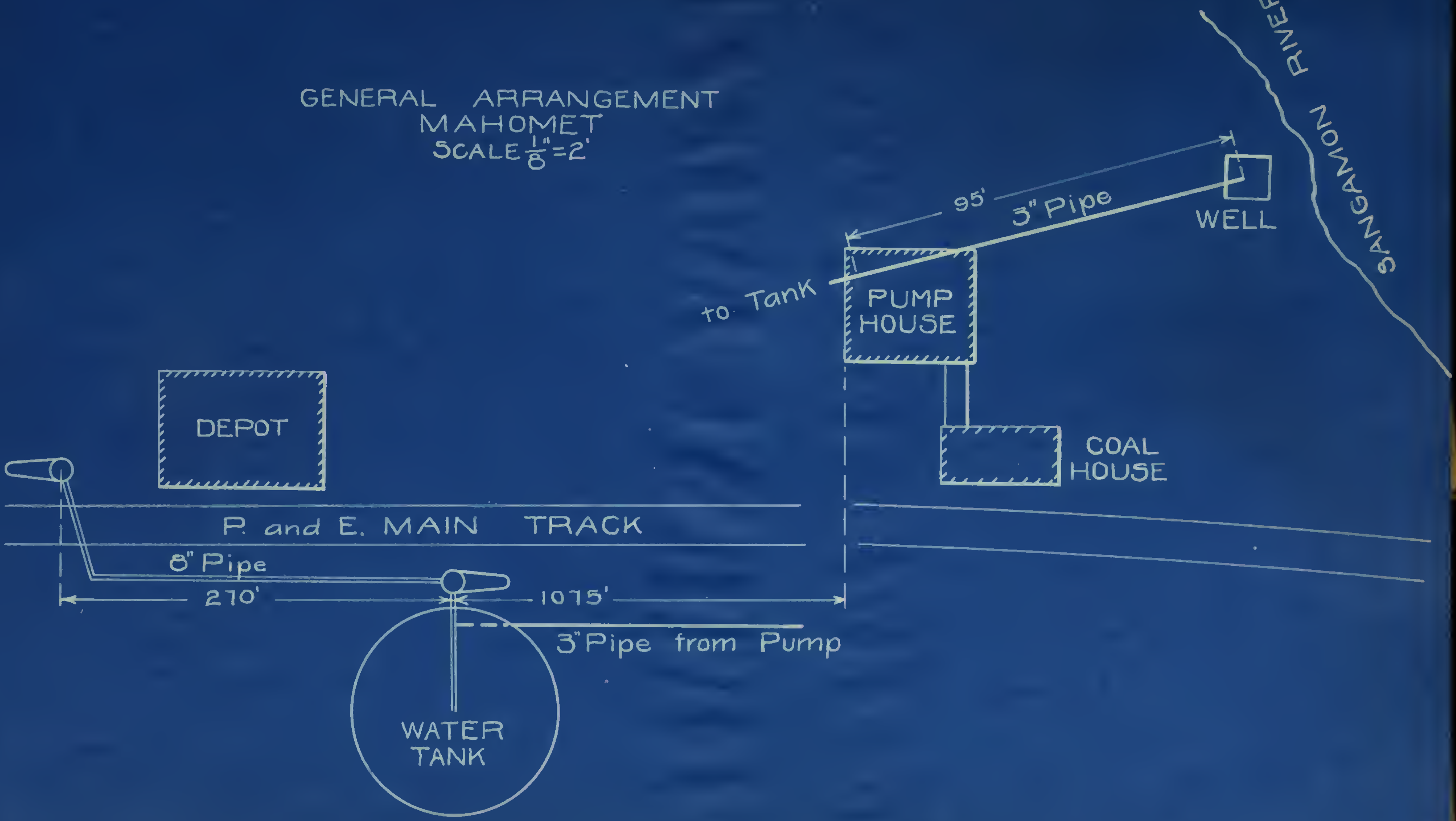
3" Discharge
1" Steam
3" Suction

PLAN
MAHOMET
Scale $\frac{3}{8}$"=1'

ELEVATION
MAHOMET
Scale $\frac{3}{8}$"=1'


3" Discharge
2" Exhaust
1" Steam
3" Suction

GENERAL ARRANGEMENT
MAHOMET
SCALE $\frac{1}{8}$"=2'


SANGAMON RIVER
WELL
95'
3" Pipe
to Tank
PUMP HOUSE
COAL HOUSE
DEPOT
P. and E. MAIN TRACK
8" Pipe
270'
1075'
3" Pipe from Pump
WATER TANK

Mahomet,

Mahomet

# URBANA, ILLINOIS.

# WATER STATION ON THE PEORIA AND EASTERN RAILWAY.

# URBANA, ILLINOIS.

## DATA FROM INSPECTION OF PLANT.

| | |
|---|---|
| Date of Installation | 1898. |
| Date of Inspection | Nov. 9, 1899. |
| Date of Co-ef. of Discharge Test | Apr. 24, 1900. |
| Date of Coal Test | Feb. 16, 1901. |
| Make of Pump | Dean. |
| Size of Pump---Douplex Double Acting | 10" x 8 1/2" x 10". |
| Number of Hours per day pump is in operation | 10. |
| Depth of Well in ft. | 15. |
| Height of Suction in ft. | 8. |
| Height of Discharge in ft. | 86. |
| Size of Tank | 30' x 20'. |

# # # # # # # # # # #

## URBANA, ILLINOIS.

### DATA RELATING TO THE CO-EFFICIENT OF DISCHARGE TEST.

| Test Number | 1. | 2. | 3. |
|---|---|---|---|
| Method Number | 1. | 1. | 1. |
| Average boiler pressure | 86.4 lbs. | 87.5 lbs. | 85 lbs. |
| Average pressure head on pump | 40 lbs. | 41.3 lbs. | 39.8 lbs. |
| Number of strokes per min. | 30. | 33.2 | 24.3 |
| Piston speed ft. per min. | 49. | 55. | 41. |
| Actual discharge, during test | 6368 gals. | 6691 gals. | 3028 gals. |
| Theoretical discharge, during test | 6666 Gals. | 7041 Gals | 3190 Gals |
| Co-efficient of discharge | 95.5 % | 95.0% | 94.9 % |
| Rate Actual per hour | 17369. | 19119. | 13959. |

# # # # # # # # # # #

# URBANA, ILLINOIS.

## DATA RELATING TO THE EFFICIENCY TEST.

| | |
|---|---|
| Duration of test | 4 hrs. 31 min. |
| Actual quantity of water pumped during test | 69278 gals. |
| Coal burned during test | 776 lbs. |
| Water evaporated during test | 3430 lbs. |
| Water evaporated per pound of coal | 4.42 lbs. |
| Coal consumed in pumping 1000 gallons of water | 11.2 lbs. |
| Work performed per pound of coal | 73013 ft. lbs. |

# # # # # # # # # # #

## URBANA, ILLINOIS.

### RESULTS OF TESTS AND INSPECTION.

| | |
|---|---|
| Water pumped per day | 173690 gals. |
| Work performed per day in lifting water | 124801394 ft. lbs. |
| Work performed from one pound of coal | 73013 ft. lbs. |
| Coal consumed per day | 1709 lbs. |
| Coal consumed per 1000 gallons of water pumped | 11.2 lbs. |
| Coal consumed per month | 51270 lbs. |

# # # # # # # # # # #

## U R B A N A, I L L I N O I S.

### TABULATED RESULTS OF CHEMICAL ANALYSIS.

| | |
|---|---|
| Amount of soda ash required for each 1000 gallons pumped | 1.07 lbs. |
| Amount of soda ash required for each hour pumped | 18.19 lbs. |
| Amount of soda ash required per day | 181.9 lbs. |
| Amount of soda ash required per month | 5457.0 lbs. |
| Cost per month for treatment with soda ash @ 2¢ per lb. | $109.14 |

# # # # # # # # # # #

## URBANA, ILLINOIS.

### RESULTS OF ESTIMATES ON COSTS.

| | |
|---|---|
| Cost of plant complete | $18842.00 |
| Cost of repairs per month at rate of 1 % per year | 15.66 |
| Amount of depreciation of plant per month @ 5 % per year | 78.50 |
| Interest per month at rate of 5 % per year | 78.50 |
| Cost of labor per month | 35.00 |
| Cost of supplies per month | 5.00 |
| Cost of coal per month @ $1.10 per ton | 29.26 |
| Total cost of pumping per month | 241.92 |
| Total cost of pumping 1000 gallons | .046 |
| Total cost of pumping per month including treatment with soda ash | 351.06 |
| Cost of coal per 1000 gallons pumped | .0063 |

# # # # # # # # # # #

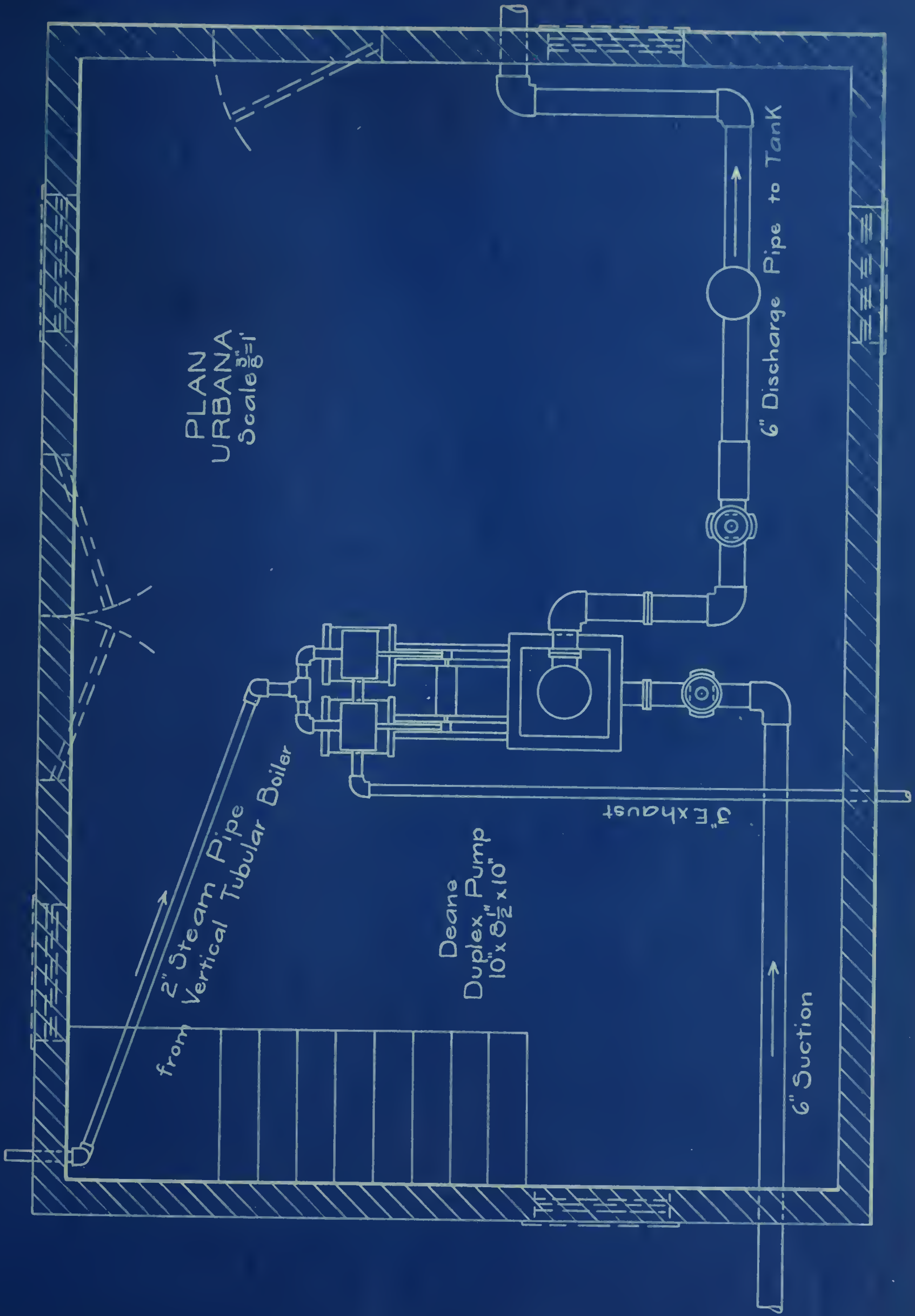
## URBANA, ILLINOIS.

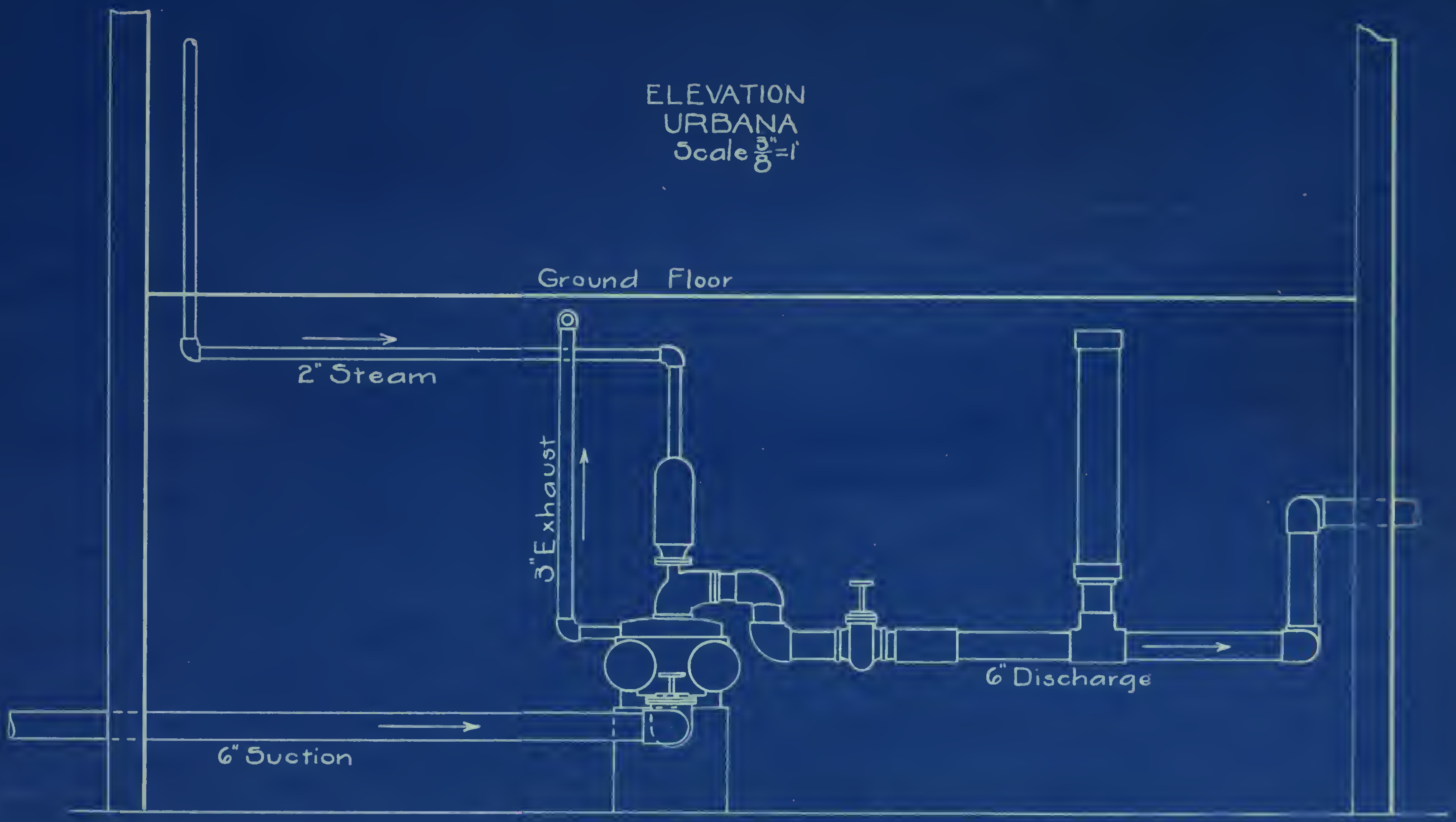
### REMARKS.

The water at this station could be treated either in the well or the tank.

The water is very bad and should receive some treatment. As the quantity of water to be treated is great it would be best to sink a well and see if better water could not be obtained.

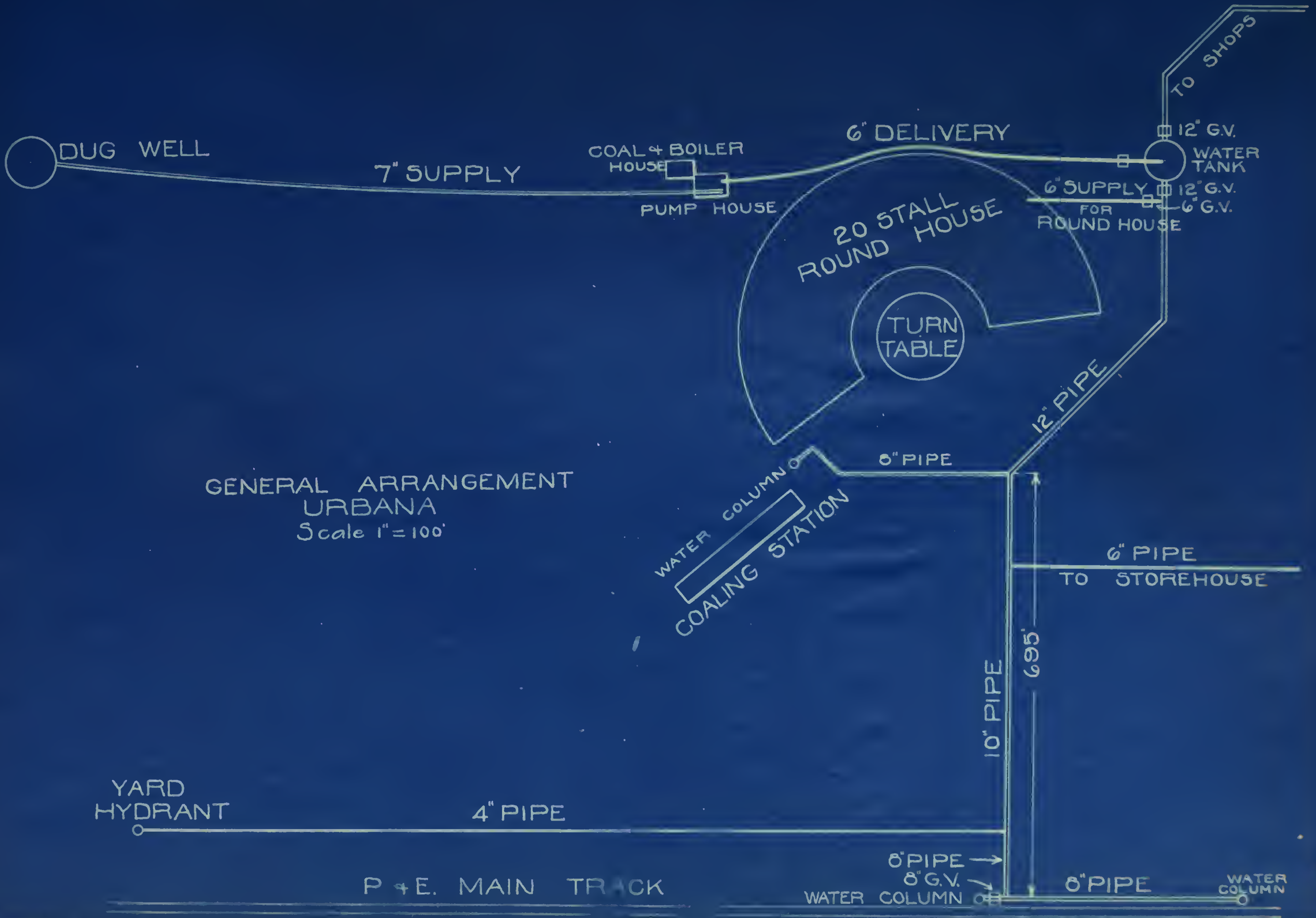
# # # # # # # # # # #


PLAN
URBANA
Scale 3/8"=1'
6" Discharge Pipe to Tank
3" Exhaust
Deane
Duplex Pump
10"x8½"x10"
2" Steam Pipe
from Vertical Tubular Boiler
6" Suction



ELEVATION
URBANA
Scale $\frac{3}{8}$"=1'

Ground Floor
2" Steam
3" Exhaust
6" Discharge
6" Suction



GENERAL ARRANGEMENT
URBANA
Scale 1" = 100'

DUG WELL
7" SUPPLY
COAL & BOILER HOUSE
PUMP HOUSE
6" DELIVERY
TO SHOPS
12" G.V.
WATER TANK
12" G.V.
6" G.V.
6" SUPPLY FOR ROUND HOUSE
20 STALL ROUND HOUSE
TURN TABLE
12" PIPE
8" PIPE
WATER COLUMN
COALING STATION
6" PIPE
TO STOREHOUSE
10" PIPE
695'
YARD HYDRANT
4" PIPE
8" PIPE
8" G.V.
WATER COLUMN
8" PIPE
WATER COLUMN
P & E. MAIN TRACK

Urbana.

Urbana,

# MUNCIE, ILLINOIS.

# WATER STATION ON THE PEORIA AND EASTERN RAILWAY.

## MUNCIE, ILLINOIS.

### DATA RELATING TO INSPECTION OF PLANT.

| | |
|---|---|
| Date of Installation | 1896. |
| Date of Inspection | Dec. 20, 1899. |
| Make of Pump | F. M. & Co. |
| Size of Pump - Double Acting | 6" x 5" x 10". |
| Number of hours per day pump is in operation | 3. |
| Height of Suction | 8 ft. |
| Height of discharge | 70 ft. |
| Size of Tank | 24' x 16'. |

# # # # # # # # # # #

## MUNCIE, ILLINOIS.

### RESULTS OF ESTIMATES.

| | |
|---|---|
| Estimated amount of water pumped per hour (Average of Eclipse Pumps.) | 7434 gals. |
| Amount of water pumped per day | 22302 gals. |
| Work performed in lifting water per day | 18025560 ft. lbs. |
| Work performed from one pound of coal (Pekin Test Figure | 31780 ft. lbs. |
| Coal consumed per day | 566 lbs. |
| Coal consumed per 1000 gals. of water pumped | 25 lbs. |
| Coal consumed per month | 16980 lbs. |

# # # # # # # # # # #

## MUNCIE, ILLINOIS.

### RESULTS OF ESTIMATES ON COSTS.

| | |
|---|---|
| Cost of plant complete | $7519.00 |
| Cost of repair per month @ 2 % per year | 12.70 |
| Amount of depreciation and interest on ~~of~~ plant per month @ rate of 9 ~~5~~ % per year | 56.39 ~~31.33~~ |
| Cost of labor per month | 20.00 |
| Cosr of supplies per month | 5.00 |
| Cost of coal per month @ $1.10 per ton | 9.88 |
| Total cost of pumping per month | 103.97 |
| Total cost of pumping 1000 gals. of water | .155 |
| Cost of coal for pumping 1000 gals. of water | .013 |

# # # # # # # # # # #

## MUNCIE, ILLINOIS.

### RESULTS OF ESTIMATES ON COSTS

### If Pumpman Also Pumped
### At Mahomet.

| | |
|---|---|
| All monthly expenses outside of labor | $83.97 |
| Cost of labor per month | 15.00 |
| Total cost of pumping per month | 98.97 |
| Total cost of pumping 1000 gallons of water | .147 |

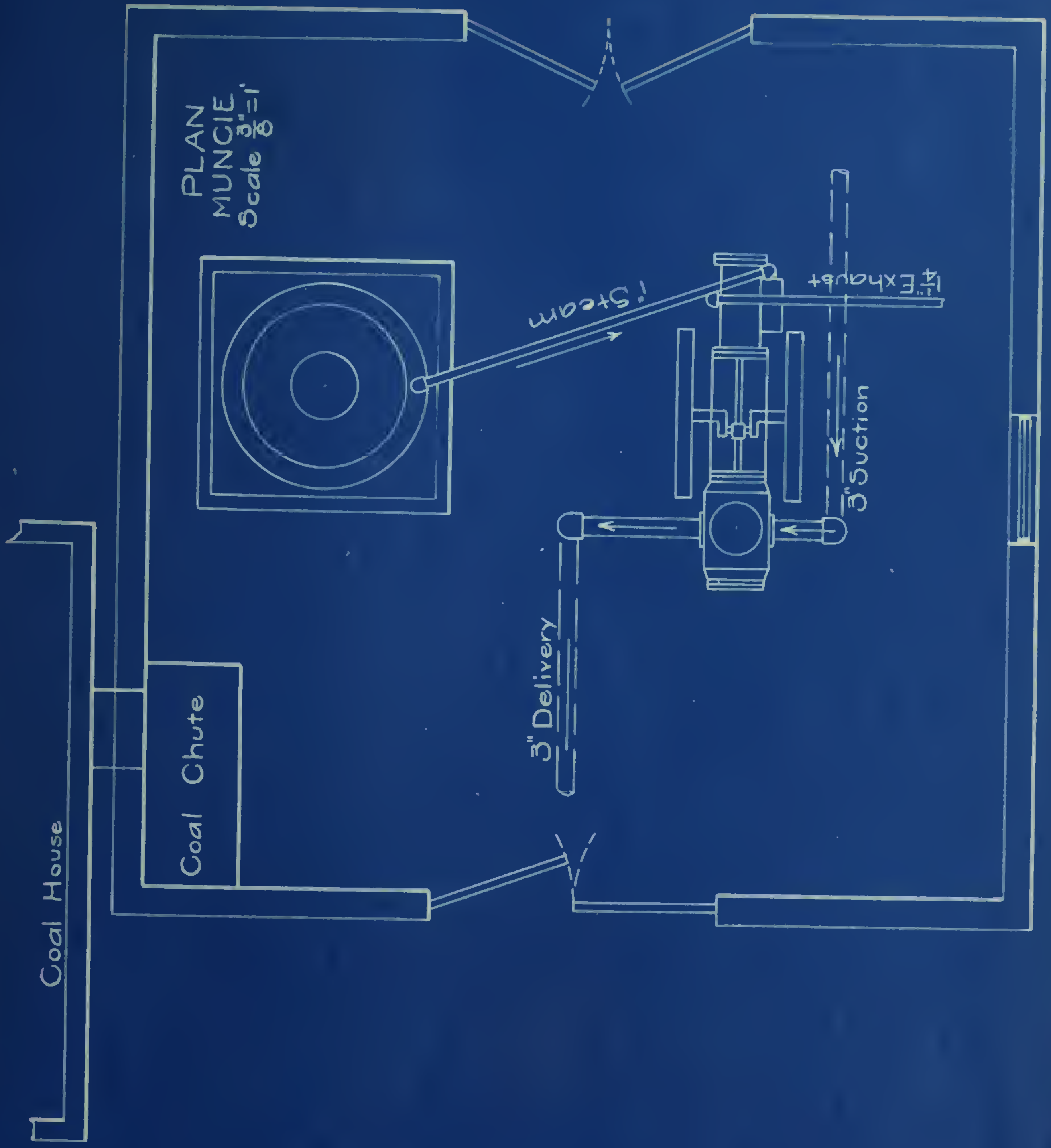
# # # # # # # # # # #

It is assumed above that the pumpman receives $15 per month for each station.

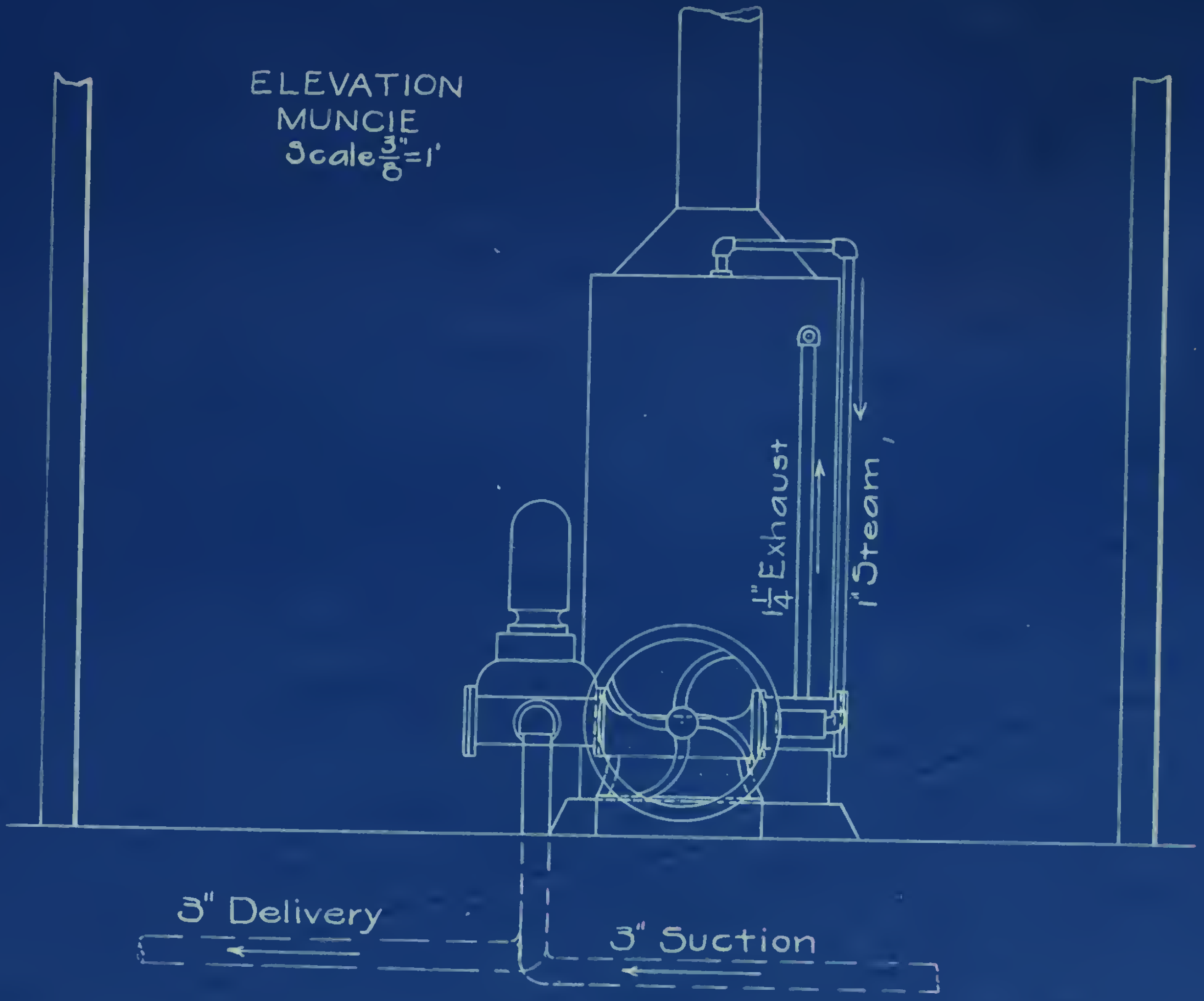
# # # # # # # # # # #

There is so little water pumped at either Mahomet or Muncie that the pumpman could very easily take care of both stations.

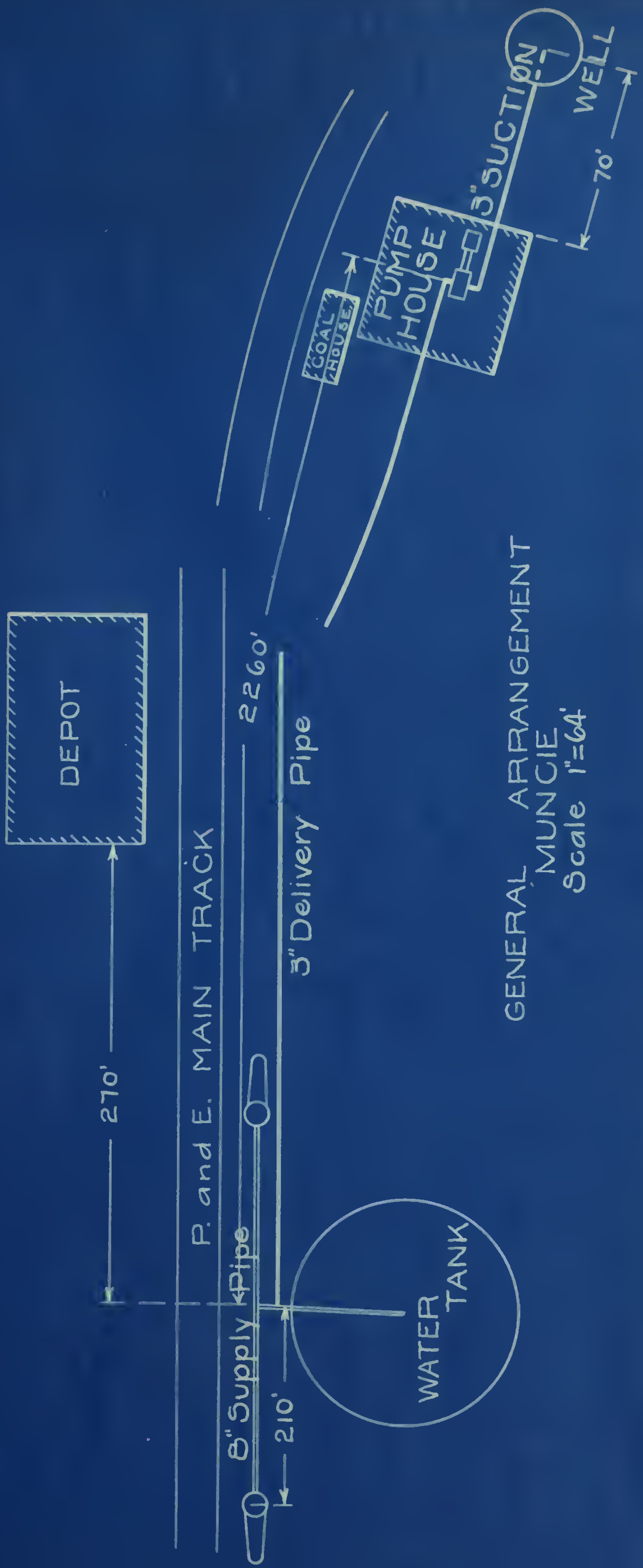
# # # # # # # # # # #


PLAN
MUNCIE
Scale 3/8"=1'
1" Steam
1 1/4" Exhaust
3" Suction
3" Delivery
Coal Chute
Coal House

ELEVATION
MUNCIE
Scale $\frac{3}{8}$"=1'



$1\frac{1}{4}$" Exhaust
1" Steam
3" Delivery
3" Suction



GENERAL ARRANGEMENT
MUNCIE
Scale 1"=64'

DEPOT
P. and E. MAIN TRACK
270'
2260'
3" Delivery Pipe
8" Supply Pipe
210'
WATER TANK
COAL HOUSE
PUMP HOUSE
3" SUCTION
WELL
70'

Muncie.

Muncie.

# DANVILLE JC., ILLINOIS.

# WATER STATION ON THE PEORIA AND EASTERN RAILWAY.

# DANVILLE JC., ILLINOIS.

## DATA RELATING TO INSPECTION OF PLANT.

| | |
|---|---|
| Date of Installation | 1895. |
| Date of Inspection | Dec. 19, 1899. |
| Date of Test | Jan. 2, 1901. |
| Make of Pump | Smith and Vail. |
| Size of Pump - Douplex Double Acting | 6" x 5 1/16" x 8". |
| Additional duties of Pumpman | Helps on turntable. |
| Number of hours per day pump is in operation | 8. |
| Height of Suction | 19.2 ft. |
| Height of Discharge | 62 ft. |
| Size of Tank | 24" x 16". |

# # # # # # # # # # #

## DANVILLE JC., ILLINOIS.

### DATA RELATING TO THE CO-EFFICIENT OF DISCHARGE TESTS.

| | | |
|---|---|---|
| Test Number | 1. | 2. |
| Method Number | 1. | 1. |
| Average boiler pressure | 70 lbs. | 80 lbs. |
| Average pressure head on pump | 50 lbs. | 50 lbs. |
| Average Number strokes per min. | 41. | 45. |
| Piston speed feet per min. | 54. | 60. |
| Duration of test | 20 min. | 20 min. |
| Theoretical discharge gals. per hour | 6838. | 7556. |
| Actual discharge gallons per hour | 5128. | 5976. |
| Co-efficient of discharge | 74.9 % | 79.8 % |
| Velocity head of issuing jet | 1.316 | 1.672 |
| Size of Nozzle | 2". | 2". |

# # # # # # # # # # #

| | |
|---|---|
| Average Actual discharge gallons per hour | 5552. |
| Average Co-efficient of discharge | 77.3 % |

## DANVILLE JC., ILLINOIS.

### RESULTS OF TESTS AND INSPECTION.

| | |
|---|---|
| Water pumped per day | 45000 gals. |
| Work performed per day in lifting water | 43137125 ft/ lbs. |
| Work performed from one pound of coal | 31780 ft. lbs. |
| Coal burned per 24 hours | 1357 lbs. |
| Coal used per 1000 gals. of water pumped | 30 lbs. |
| Coal burned per month | 40710 lbs. |

# # # # # # # # # # #

## DANVILLE JC., ILLINOIS.

### TABULATED RESULTS OF CHEMICAL ANALYSIS.

| | |
|---|---|
| Soda ash required for each 1000 gals. of water | 1.59 lbs. |
| Soda ash required for each hour pumped | 8.74 lbs. |
| Soda ash required per day | 71.55 lbs. |
| Soda ash required per month | 2146.5 lbs. |
| Cost per month for treatment with soda ash @ 2¢ per lb. | $42.93 |

# # # # # # # # # # #

### REMARKS.

The pump at this station is in very bad condition and should be repaired. Suction head of 21 ft. is very high for Duplex pumps. The water makes a medium hard scale.

# # # # # # # # # # #

The foot pounds of work done per pound of coal which is used in calculating the cost of operation of this plant was obtained from the Pekin test.

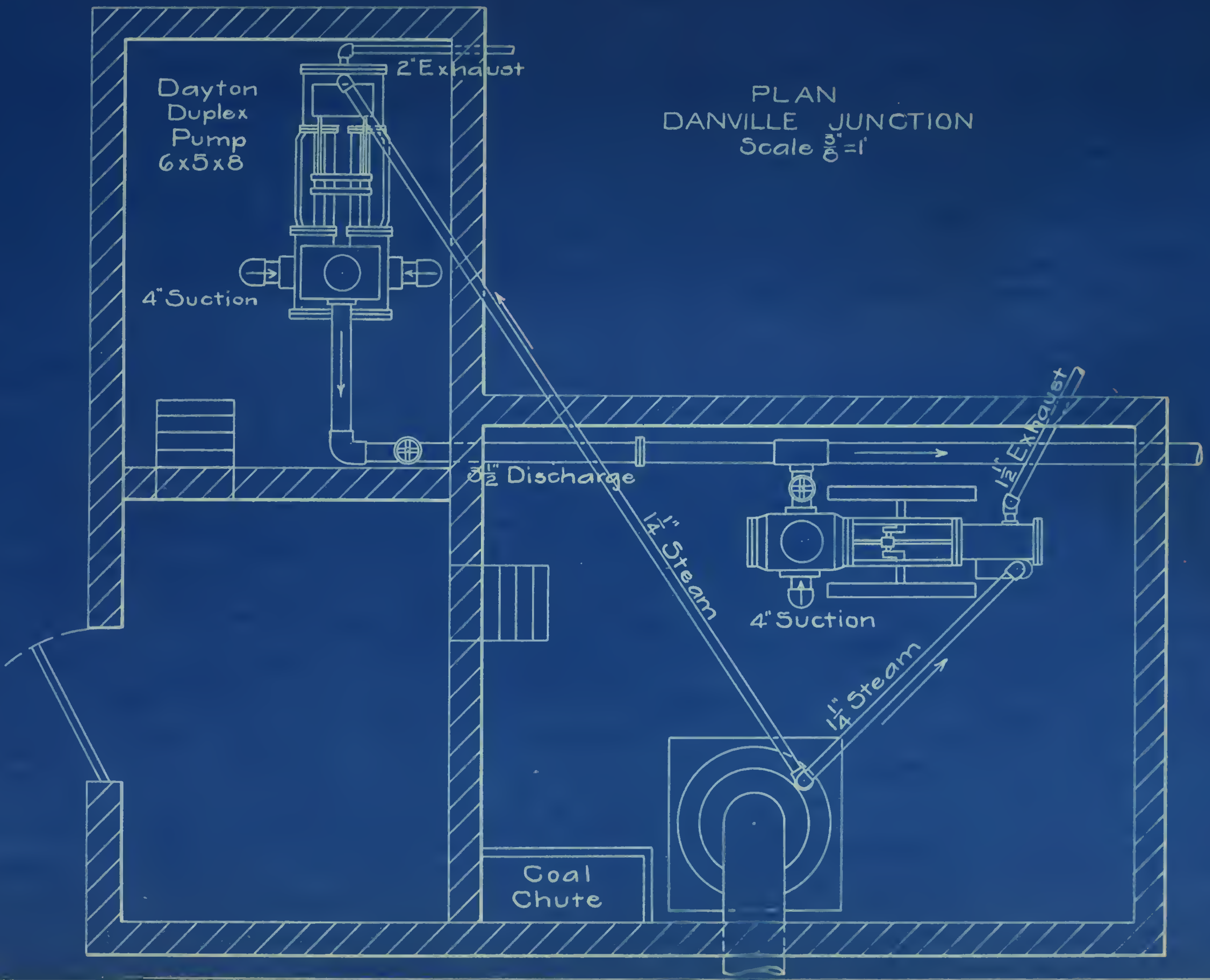
## DANVILLE JC., ILLINOIS.

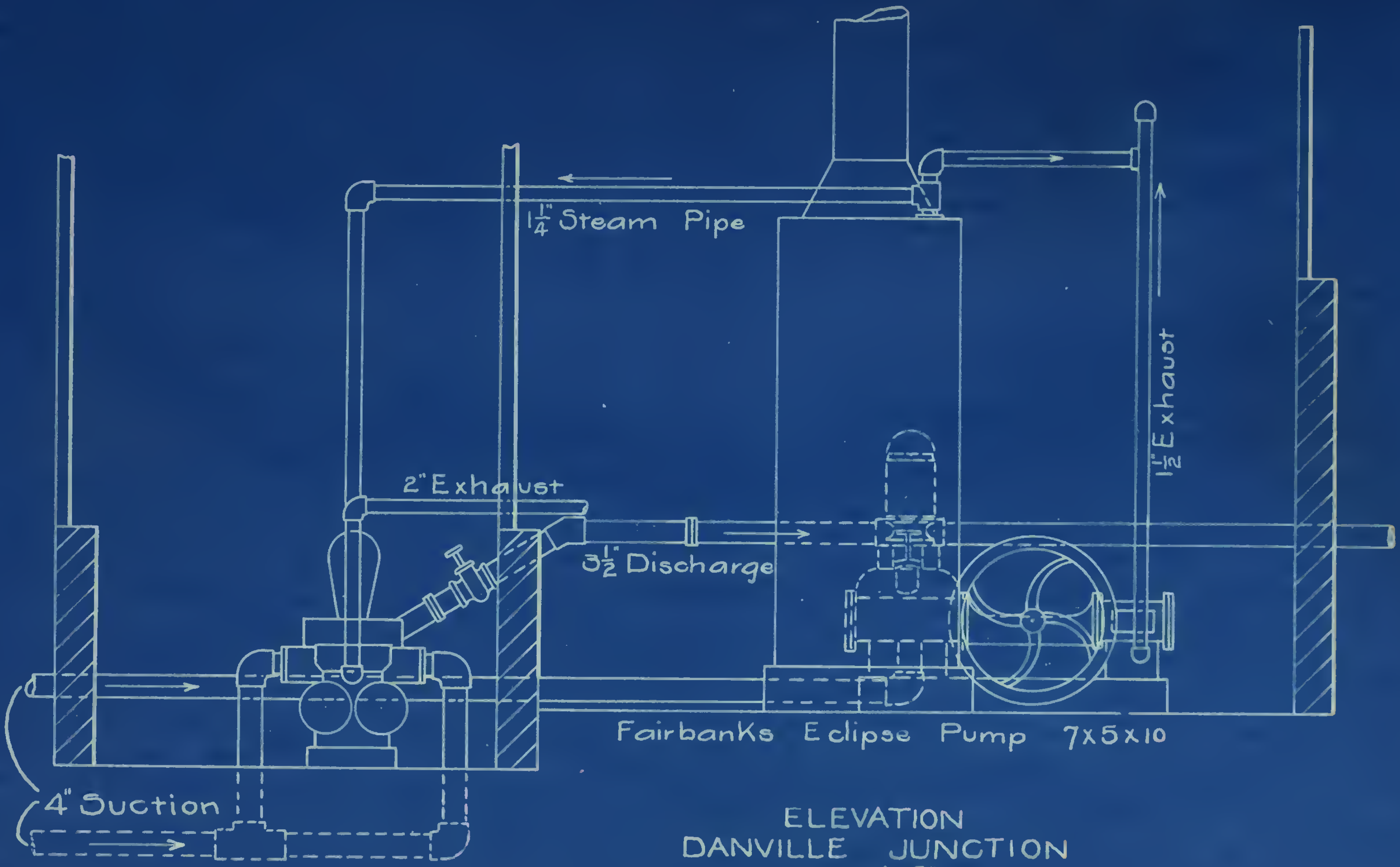
### RESULTS OF ESTIMATES ON COSTS.

| | |
|---|---|
| Cost of plant complete | $4607.00 |
| Cost of repairs per month at the rate of 3 % per year | 11.50 |
| Amount of depreciation of plant per month @ rate of 5 % per year | 19.20 |
| Interest per month at rate of 5 % per year | 19.20 |
| Cost of labor per month | 30.00 |
| Cost of supplies | 5.00 |
| Cost of coal per month @ $1.10 per ton | 22.33 |
| Total cost of pumping per month | 107.23 |
| Total cost of pumping 1000 gallons | .079 |
| Total cost per month including treatment with soda ash | 150.16 |
| Cost of coal consumed in pumping 1000 gallons | .016 |

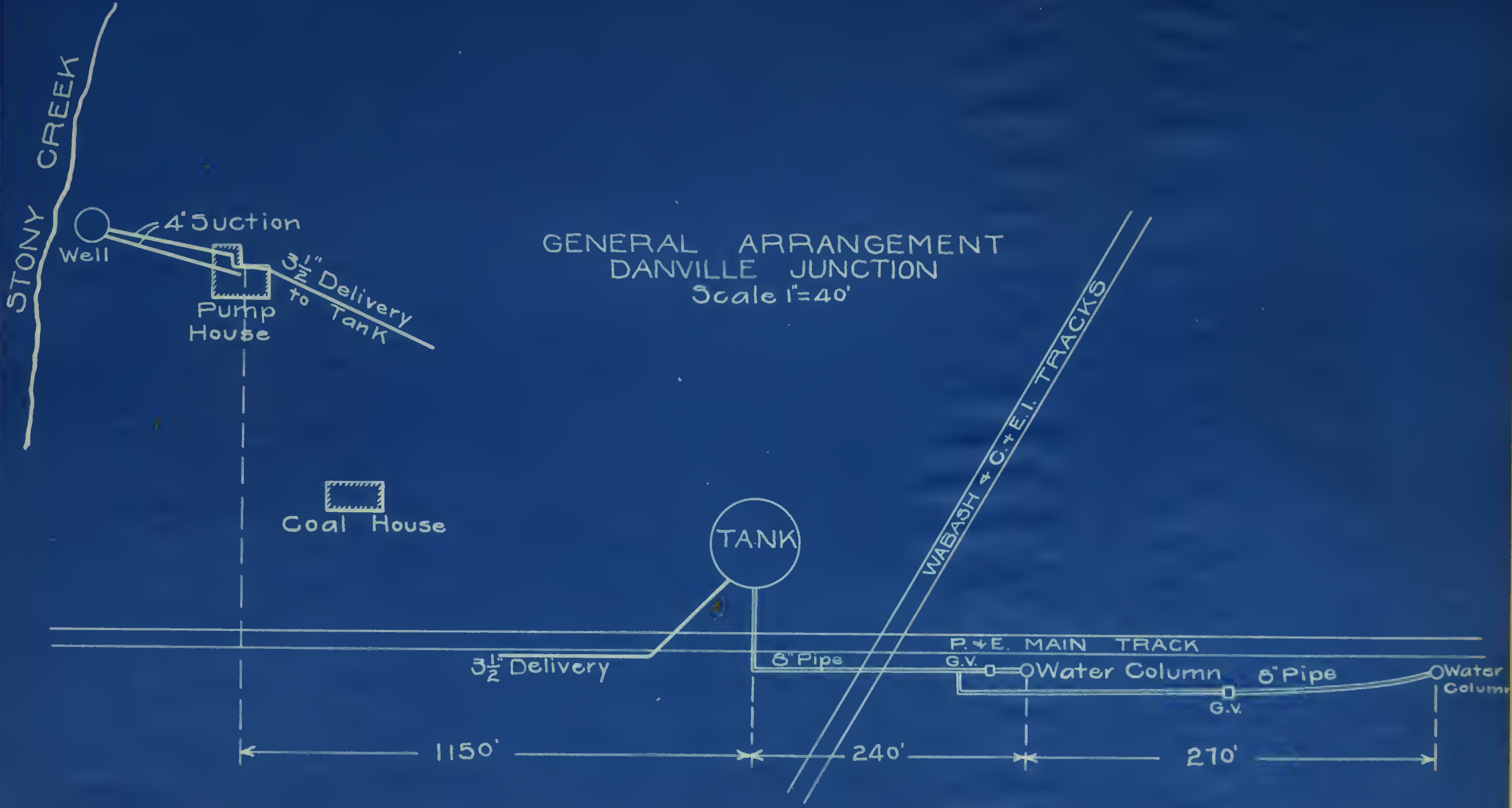
# # # # # # # # # # #

PLAN
DANVILLE JUNCTION
Scale $\frac{3}{8}"=1'$


Dayton
Duplex
Pump
6x5x8
2" Exhaust
4" Suction
$3\frac{1}{2}"$ Discharge
$1\frac{1}{4}"$ Steam
$1\frac{1}{2}"$ Exhaust
4" Suction
$1\frac{1}{4}"$ Steam
Coal
Chute


1¼" Steam Pipe
1½" Exhaust
2" Exhaust
3½" Discharge
Fairbanks Eclipse Pump 7x5x10
4" Suction

ELEVATION
DANVILLE JUNCTION
Scale $\frac{3}{8}$"=1'


GENERAL ARRANGEMENT
DANVILLE JUNCTION
Scale 1"=40'

STONY CREEK
Well
4' Suction
Pump House
$3\frac{1}{2}$" Delivery to Tank
Coal House
TANK
WABASH + C.+E.I. TRACKS
P.+E. MAIN TRACK
$3\frac{1}{2}$" Delivery
8" Pipe
G.V.
Water Column
8" Pipe
G.V.
Water Column
1150'
240'
210'

Danville.

Danville Jc.

# VEEDERSBURG, INDIANA.

## WATER STATION ON THE PEORIA AND EASTERN RAILWAY.

# VEEDERSBURG, INDIANA.

## DATA FROM INSPECTION OF PLANT.

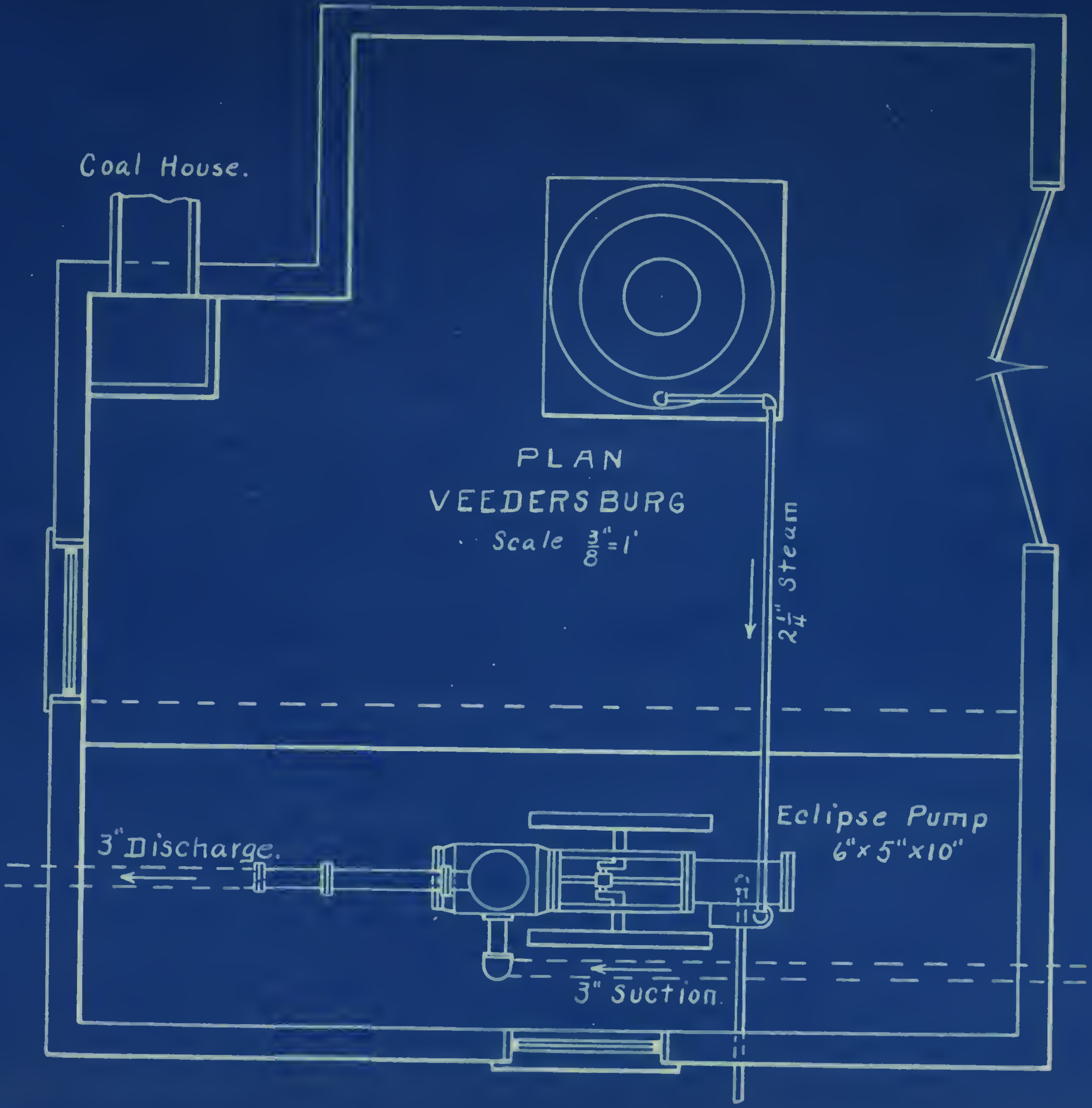
| | |
|---|---|
| Date of Installation | 1895. |
| Date of Inspection | Dec. 18, 1899. |
| Make of Pump | F. M. & Co. |
| Size of Pump | 6" x 5" x 10". |
| Number of hours per day that pump is in operation. | 4. |
| Height of Suction | 12 ft. |
| Height of Discharge | 66 ft. |
| Size of Tank | 24' x 16'. |
| Distance of pump house from station | 1175 ft. |

# # # # # # # # # # #

## REMARKS.

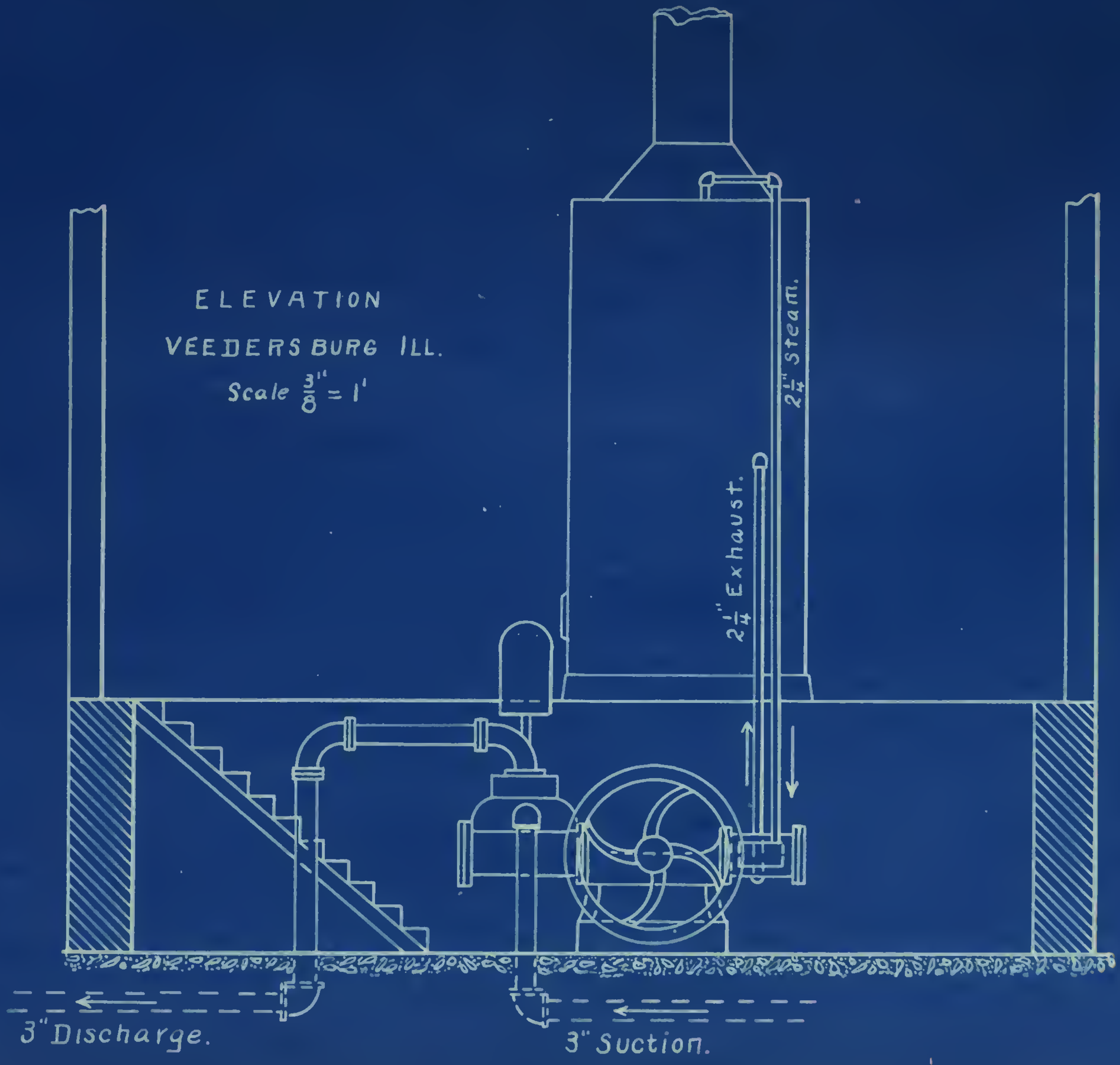
The water at this station is good. There is enough water pumped here to warrant a pumpman.

# # # # # # # # # # #



PLAN
VEEDERSBURG
Scale $\frac{3}{8}'' = 1'$

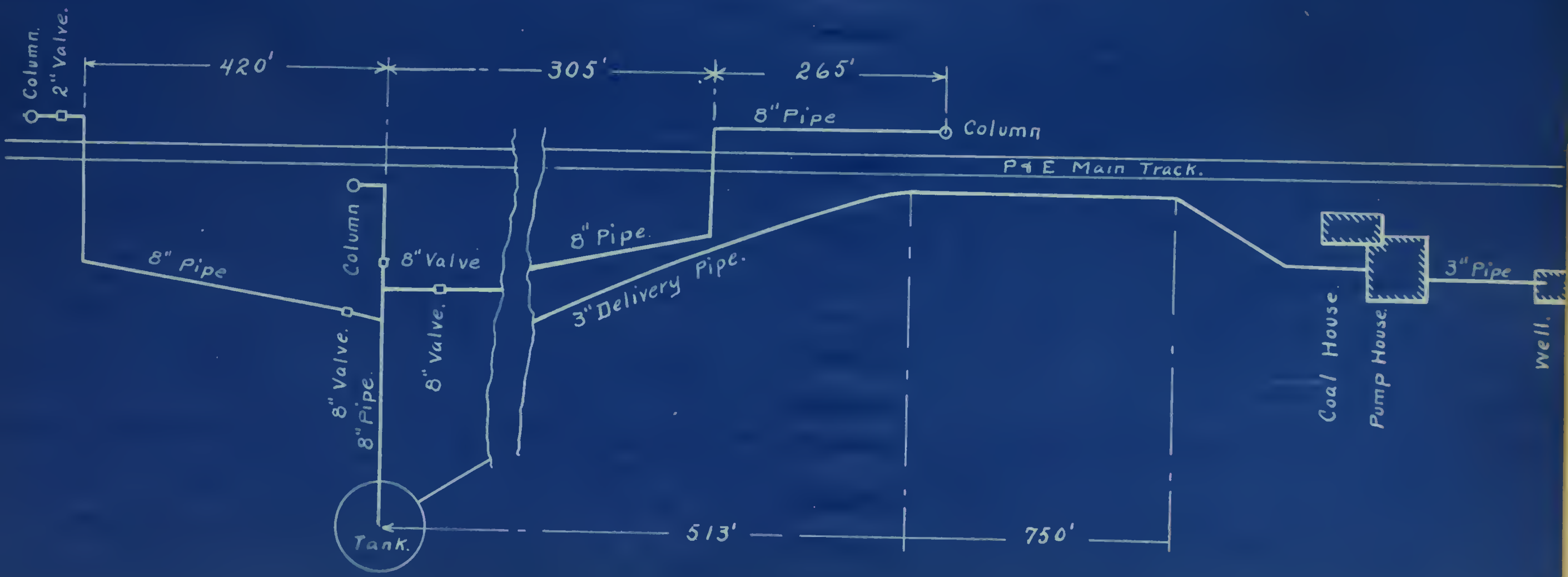
Coal House.
$2\frac{1}{4}''$ Steam
Eclipse Pump
6"x5"x10"
3" Discharge.
3" Suction.



ELEVATION
VEEDERSBURG ILL.
Scale $\frac{3}{8}'' = 1'$

2¼" Steam.
2¼" Exhaust.
3" Discharge.
3" Suction.

## GENERAL PLAN.
## VEEDERSBURG ILL.


Column.
2" Valve.
420'
305'
265'
8" Pipe
Column
P & E Main Track.
Column
8" Valve
8" Pipe
8" Pipe.
8" Valve.
8" Pipe.
8" Valve.
3" Delivery Pipe.
Tank.
513'
750'
Coal House.
Pump House.
3" Pipe
Well.

Veedersburg.

Veedersburg.

# WAYNETOWN, INDIANA.

# WATER STATION ON THE PEORIA AND EASTERN RAILWAY.

## WAYNETOWN, INDIANA.

### DATA RELATING TO INSPECTION OF PLANT.

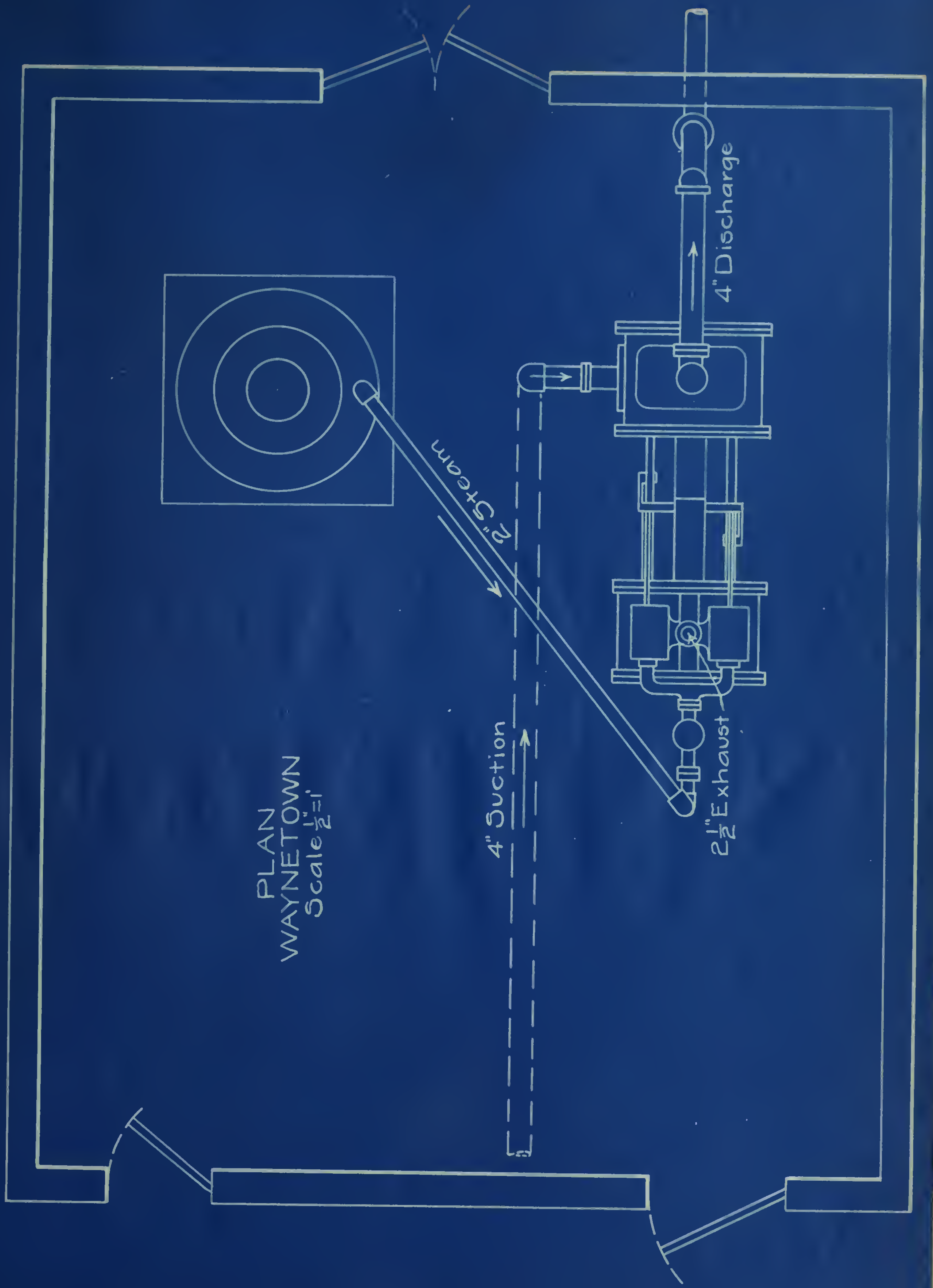
| | |
|---|---|
| Date of Installation | 1893. |
| Date of Inspection | Dec. 18, 1899. |
| Make of Pump | F. M. & Co. |
| Size of Pump - Douplex Double Acting | 10" x 6" x 10". |
| Additional duties of pumpman | Pumps at Veedersburg. |
| Number of hours per day pump is in operation | 2. |
| Height of Suction | 12 ft. |
| Height of Discharge | 66 ft. |
| Size of Tank | 24' x 16'. |

# # # # # # # # # # #

### REMARKS.

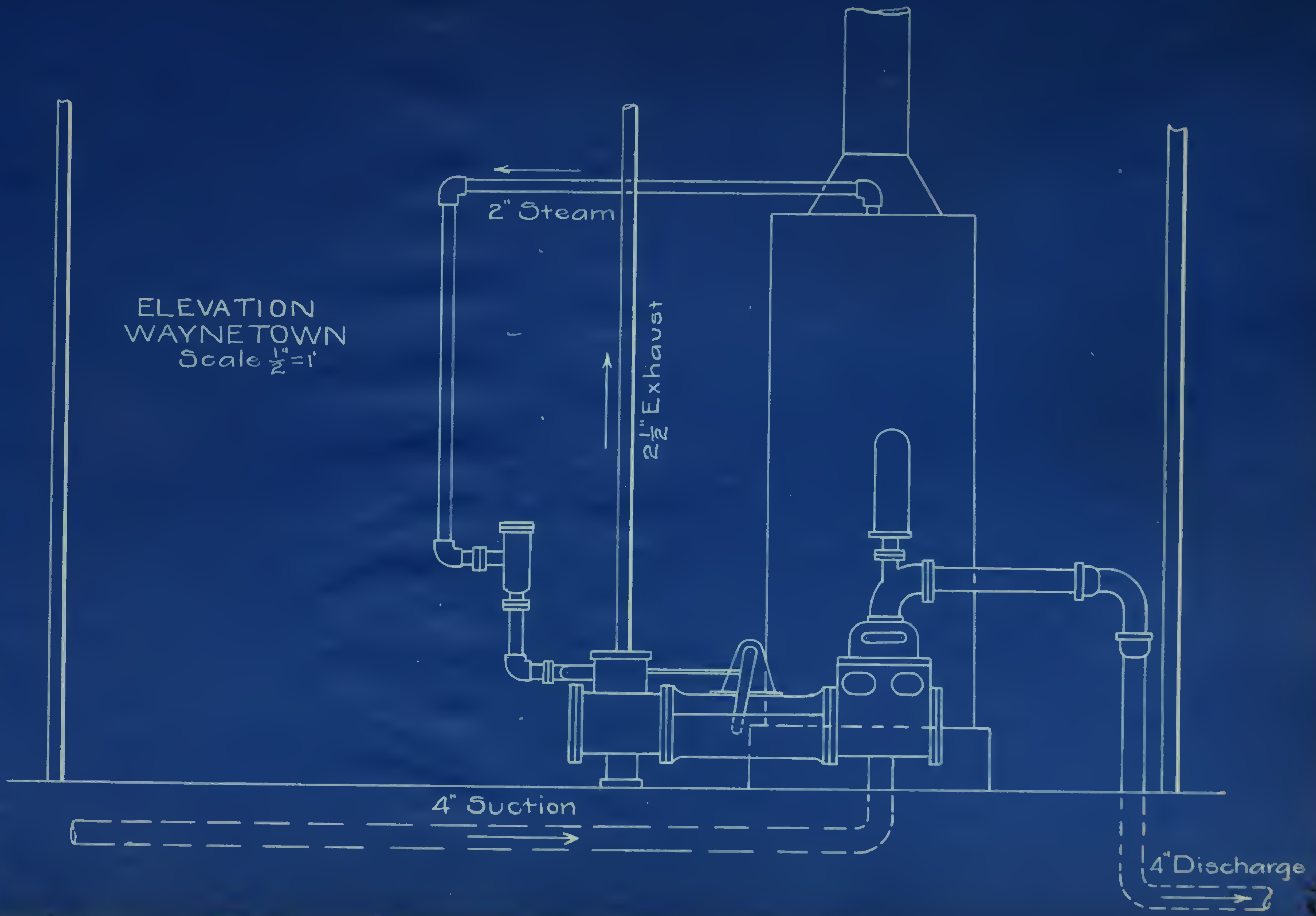
The water at this station is very good.

# # # # # # # # # # #



PLAN
WAYNETOWN
Scale $\frac{1}{2}$"=1'

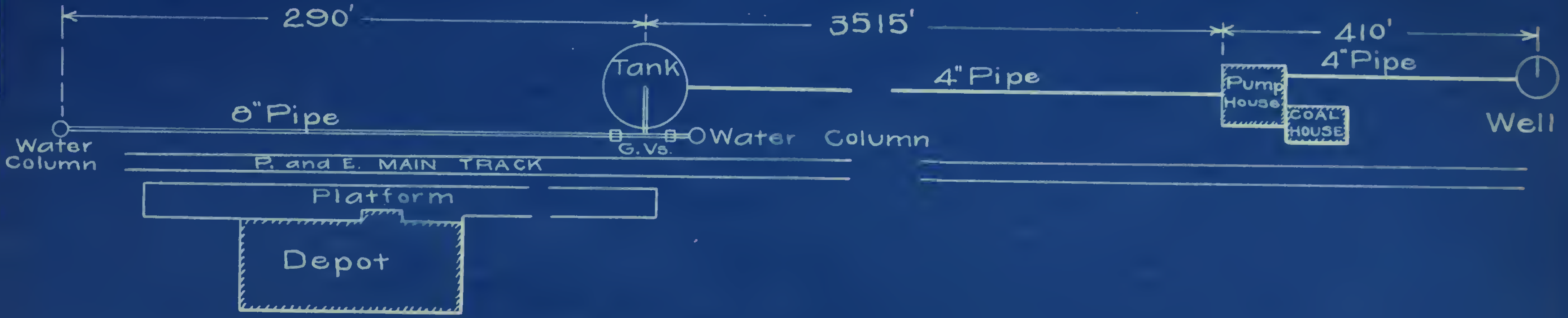
4" Discharge
2" Steam
4" Suction
$2\frac{1}{2}$" Exhaust


ELEVATION
WAYNETOWN
Scale $\frac{1}{2}$"=1'

2" Steam
2$\frac{1}{2}$" Exhaust
4" Suction
4" Discharge

# GENERAL ARRANGEMENT
# WAYNETOWN

Scale 1"=40'


290'
3515'
410'
Tank
4" Pipe
4" Pipe
Pump House
COAL HOUSE
Well
8" Pipe
Water Column
G. Vs.
Water Column
P. and E. MAIN TRACK
Platform
Depot

Waynetown.

# CRAWFORSVILLE, INDIANA.

# WATER STATION ON THE PEORIA
# AND
# EASTERN RAILROAD.

## CRAWFORSVILLE, INDIANA.

### DATA FROM INSPECTION OF PLANT.

| | |
|---|---|
| Date of Installation | 1898. |
| Date of Inspection | Dec. 16, 1899. |
| Date of Test | June 5, 1900. |
| Make of Pump | Cook. |
| Size of Pump | 10" x 9 1/2" x 36". |
| Number of hours per day pump is in operation | 10. |
| Depth of well | 225 ft. |
| Height of discharge - i.e.- From top of water in well to top of tank | 71 ft. |
| Size of Tank | 24' x 16'. |

# # # # # # # # # # #

## CRAWFORSVILLE, INDIANA.

### DATA RELATING TO THE CO-EFFICIENT OF DISCHARGE TEST.

| Test Number | 1. | 2. | 3. |
|---|---|---|---|
| Method Number | 1. | 1. | 1. |
| Average boiler pressure | 58 lbs. | 59 lbs. | 62 lbs. |
| Average pressure head on pump | 25 lbs. | 22 lbs. | 25 lbs. |
| Average number of strokes per min. | 16.8 | 18.1 | 19.7 |
| Piston speed ft. per min. | 100 | 108 | 118 |
| Theoretical discharge per hour | 11128 gals. | 11989 gals. | 13049 gals. |
| Actual discharge per hour | 8964 gals. | 10284 gals. | 11232 gals. |
| Co-efficient of discharge | 80.6 % | 85.8 % | 86 % |
| Duration of test | 10 min. | 10 min. | 10 min. |
| Mean velocity head | .959 | 1.22 | 1.44 |

# # # # # # # # # # #

## CRAWFORSVILLE, INDIANA.

### RESULTS OF TESTS AND INSPECTION.

| | |
|---|---|
| Water pumped per day | 102840 gals. |
| Work performed per day in lifting water | 61,005,188 ft. lbs. |
| Work per formed from one pound of coal (Mackinaw Test) | 49780 ft.lbs. |
| Coal consumed per day | 1225 lbs. |
| Coal consumed per 1000 gals. of water pumped | 11.9 lbs. |
| Coal consumed per month | 36750 lbs. |

###########

### REMARKS.

This plant is one of the best on the road and had the best appearance of all the plants inspected. The water is good and forms no scale.

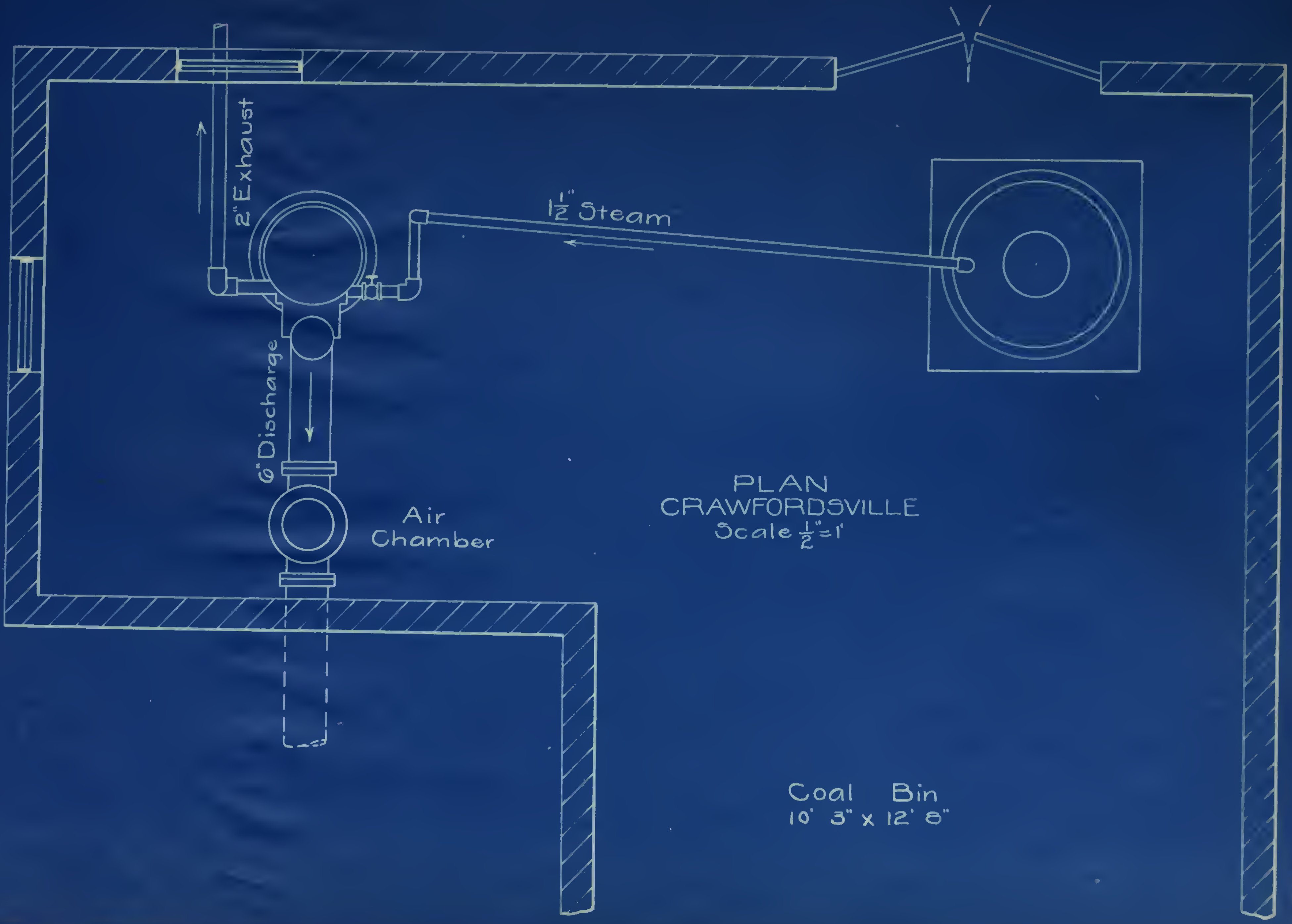
###########

# CRAWFORSVILLE, INDIANA.

## RESULTS OF ESTIMATES OF COSTS.

| | |
|---|---|
| Cost of plant complete | $6971.00 |
| Cost of repairs per month at rate of 2 % per year | 11.61 |
| Amount of depreciation of plant per month at 5 % per year | 29.04 |
| Interest on investment per month at rate of 5 % per year | 29.04 |
| Cost of labor per month | 22.50 |
| Cost of supplies per month | 5.00 |
| Cost of coal per month at $1.10 per ton | 20.21 |
| Total cost of pumping per month | 117.40 |
| Total cost of pumping 1000 gallons | .038 |
| Cost of coal consumed in pumping 1000 gallons | .0065 |

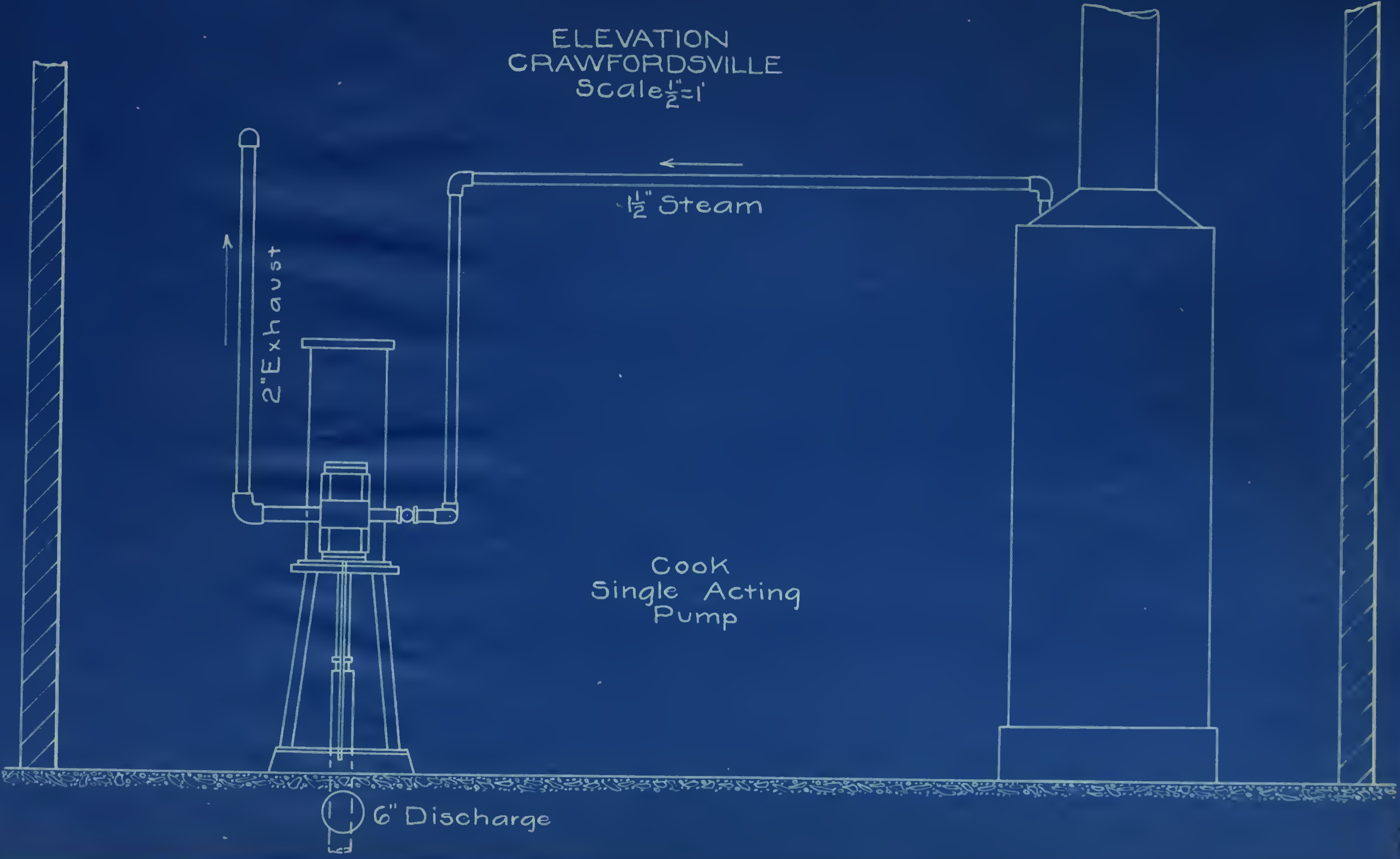
# # # # # # # # # # #



PLAN
CRAWFORDSVILLE
Scale $\frac{1}{2}$"=1'

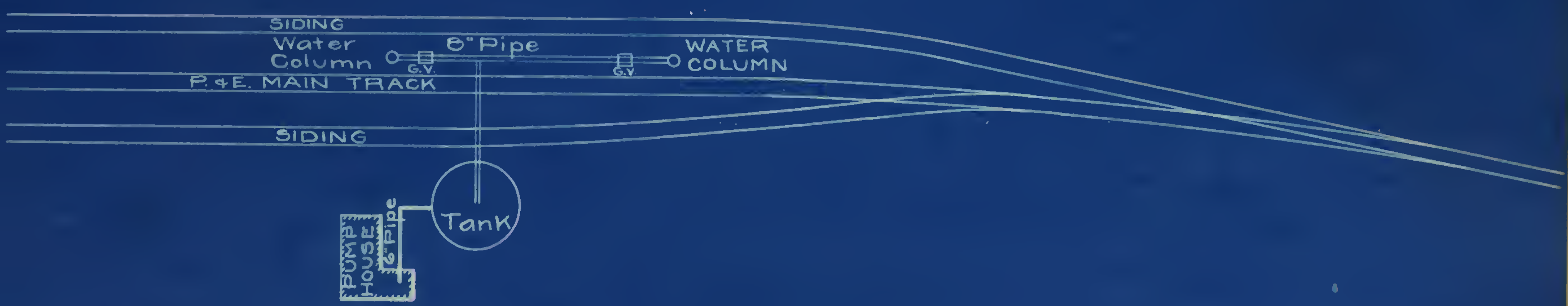
2" Exhaust
$1\frac{1}{2}$" Steam
6" Discharge
Air Chamber
Coal Bin
10' 3" x 12' 8"

ELEVATION
CRAWFORDSVILLE
Scale $\frac{1}{2}$" = 1'


1½" Steam
2" Exhaust
Cook
Single Acting
Pump
6" Discharge

## GENERAL ARRANGEMENT
## CRAWFORDSVILLE

Scale 1" = 40'


SIDING
Water Column
8" Pipe
G.V.
G.V.
WATER COLUMN
P. & E. MAIN TRACK
SIDING
Tank
6" Pipe
PUMP HOUSE

Crawfordsville,

# JAMESTOWN, INDIANA.

# WATER STATION ON THE PEORIA AND EASTERN RAILWAY.

## JAMESTOWN, INDIANA.

### DATA FROM INSPECTION OF PLANT.

| | |
|---|---|
| Date of Installation | 1893. |
| Date of Inspection | Dec. 16 1899. |
| Date of Test | ~~June~~ Jan. 4, 1900. |
| Make of Pump | F. M. & Co. |
| Size of Pump - Douplex Double Acting | 10" x 6" x 10 1/2". |
| Number of hours per day pump is in operation | 6. |
| Height of Suction | 15 ft. |
| Height of Discharge | 151.8 ft. |
| Size of Tank | 24' x 16'. |

###########

## JAMESTOWN, INDIANA.

### DATA RELATING TO THE CO-EFFICIENT OF DISCHARGE TEST.

| | |
|---|---|
| Method Number | 2. |
| Average boiler pressure | 84 lbs. |
| Average pressure head on pump | 66 lbs. |
| Average number of strokes per min | 28. |
| Piston speed ft. per min. | 48. |
| Duration of Test | 1 hr. |
| Theoretical discharge per hour | 8653 gals. |
| Actual discharge per hour | 6575 gals. |
| Co-efficient of discharge | 76 % |

# # # # # # # # # # #

## JAMESTOWN, INDIANA.

### RESULTS OF TESTS AND INSPECTION.

| | |
|---|---|
| Water pumped per day | 39450 gals. |
| Work performed per day in lifting water | 49768090 ft. lbs. |
| Work obtained from one pound of coal | 31780 ft. lbs. |
| Coal consumed per day | 1566 lbs. |
| Coal consumed per 1000 gals. of water pumped | 40 lbs. |
| Coal consumed per month | 46980 lbs. |

# # # # # # # # # # #

## JAMESTOWN INDIANA.

### RESULTS OF ESTIMATES ON COSTS.

| | |
|---|---|
| Cost of plant complete | $8035.00 |
| Cost of repairs per month at 2 % per year | 13.39 |
| Amount of depreciation of plant per month @ the rate of 5 % per year | 33.48 |
| Interest per month on investment @ rate of 5 % per year | 33.48 |
| Cost of labor per month | 25.00 |
| Cost of supplies per month | 5.00 |
| Cost of coal per month @ $1.10 per ton | 25.74 |
| Total cost of pumping per month | 136.09 |
| Total cost of pumping 1000 gals. of water | .115 |
| Cost of coal consumed in pumping 1000 gals. of water | .022 |
| Cost of pumping 1000 gallons including cost of treatment of water with soda ash | 172.45 |

# # # # # # # # # # #

## JAMESTOWN, INDIANA.

### TABULATED RESULTS OF CHEMICAL ANALYSIS.

| | |
|---|---|
| Soda ash required for each 1000 gals.of water | 1.54 |
| Soda ash required for each hour pumped | 10.1 |
| Soda ash required per day | 60.6 |
| Soda ash required per month | 1818. |
| Cost per month for treatment of water with soda ash @ 2¢ per pound | $36.36 |

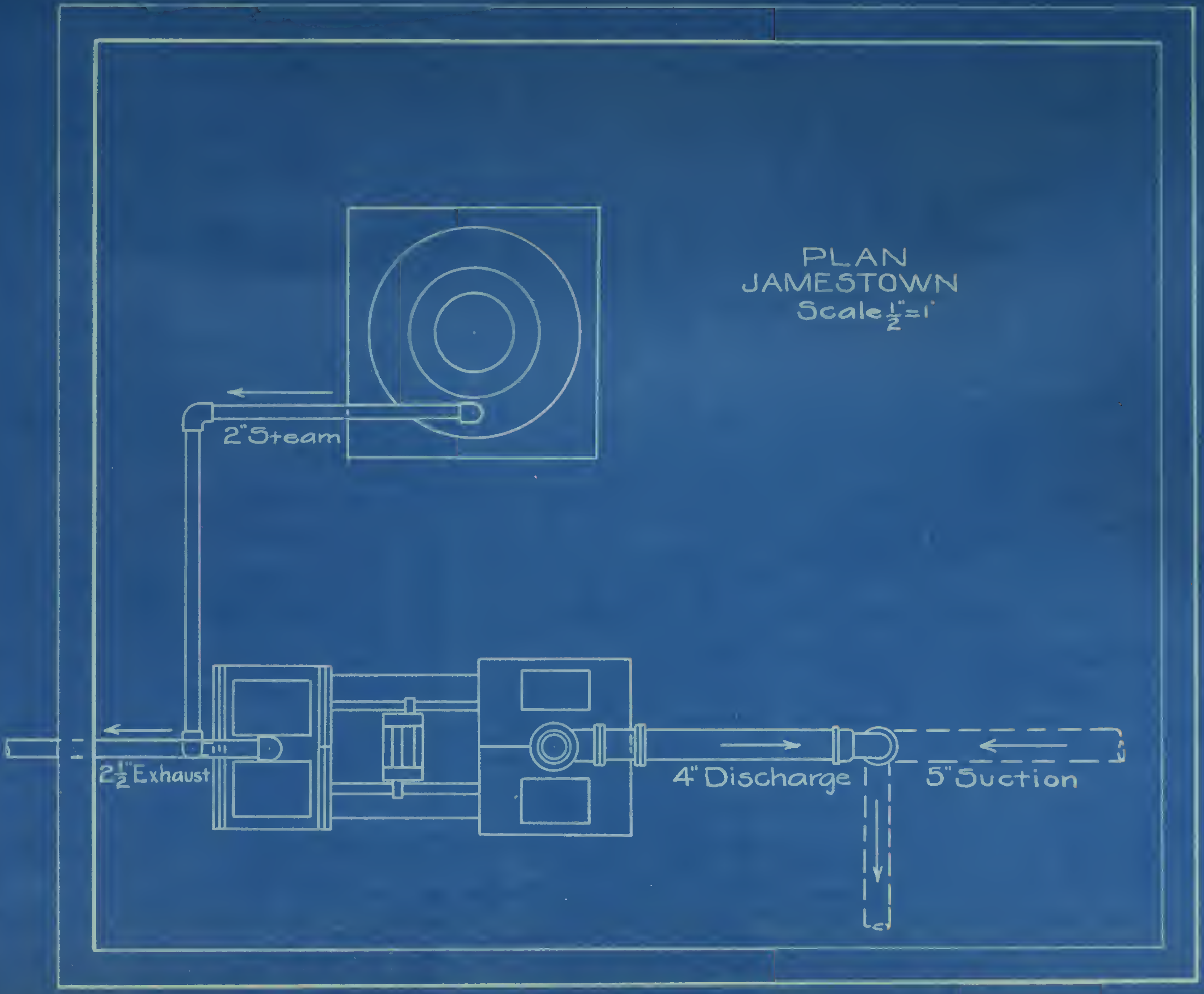
# # # # # # # # # # #

### REMARKS.

The water makes a medium hard scale and is taken from a well near a river which is affected by floods.

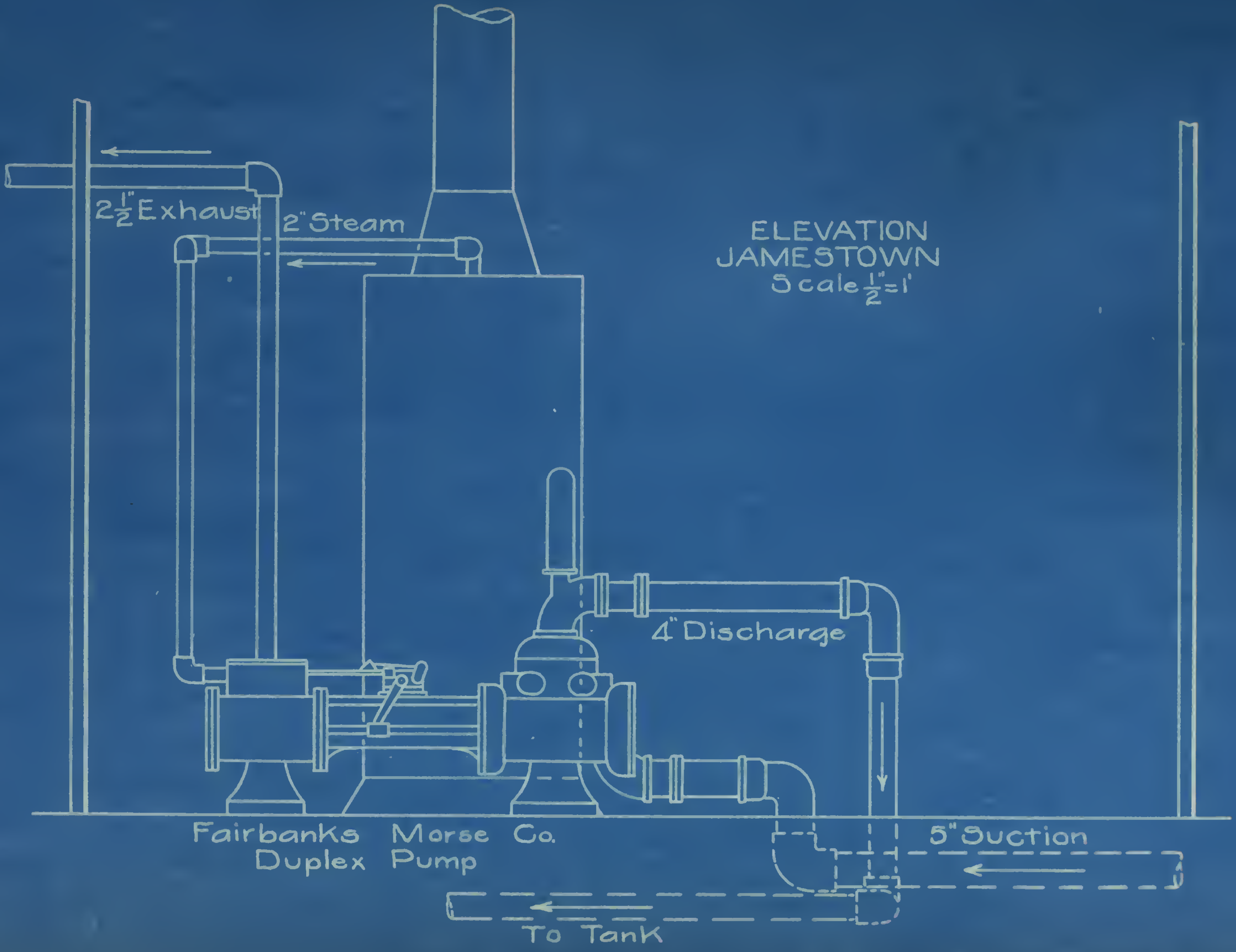
The plant is one mile from the station which causes a great deal of pipe friction in pumping. The pump here is in very bad condition.

# # # # # # # # # # #



PLAN
JAMESTOWN
Scale $\frac{1}{2}$"=1'

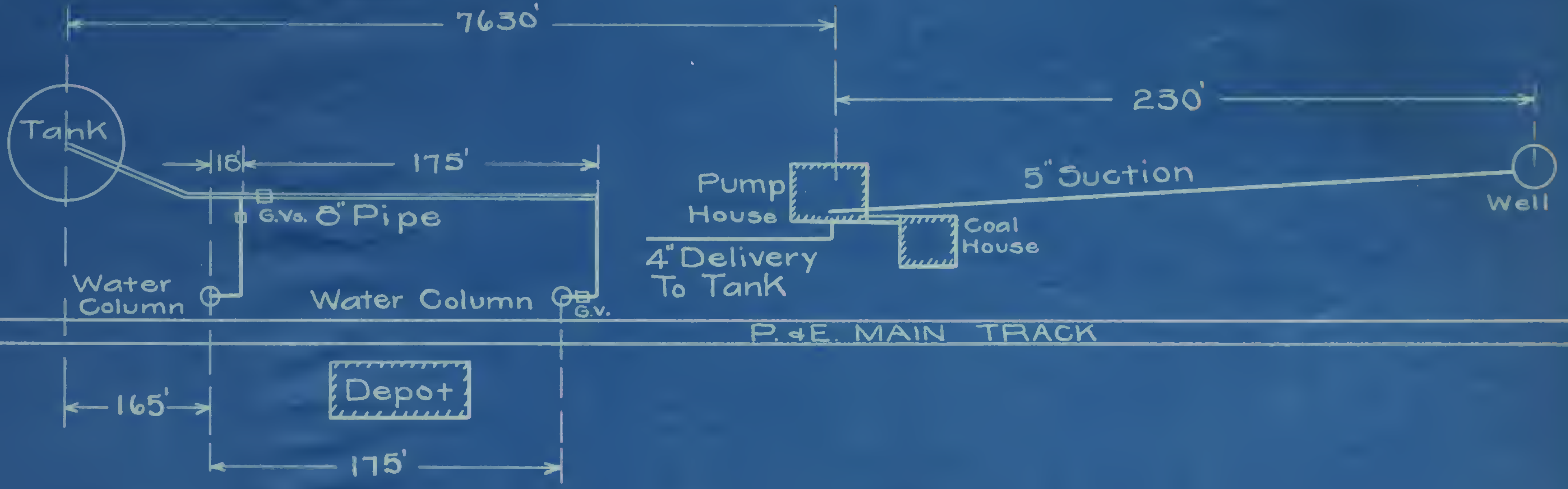
2" Steam
2$\frac{1}{2}$" Exhaust
4" Discharge
5" Suction



ELEVATION
JAMESTOWN
Scale $\frac{1}{2}$"=1'
$2\frac{1}{2}$" Exhaust
2" Steam
4" Discharge
5" Suction
Fairbanks Morse Co.
Duplex Pump
To Tank

# GENERAL ARRANGEMENT
# JAMESTOWN

Scale 1" = 40'


7630'
230'
Tank
18'
175'
G.Vs. 8" Pipe
Pump House
5" Suction
Well
Coal House
4" Delivery To Tank
Water Column
Water Column
G.V.
P. & E. MAIN TRACK
Depot
165'
175'

Jamestown,

# BROWNSBURG.

# WATER STATION ON THE PEORIA AND EASTERN RAILWAY.

## BROWNSBURG.

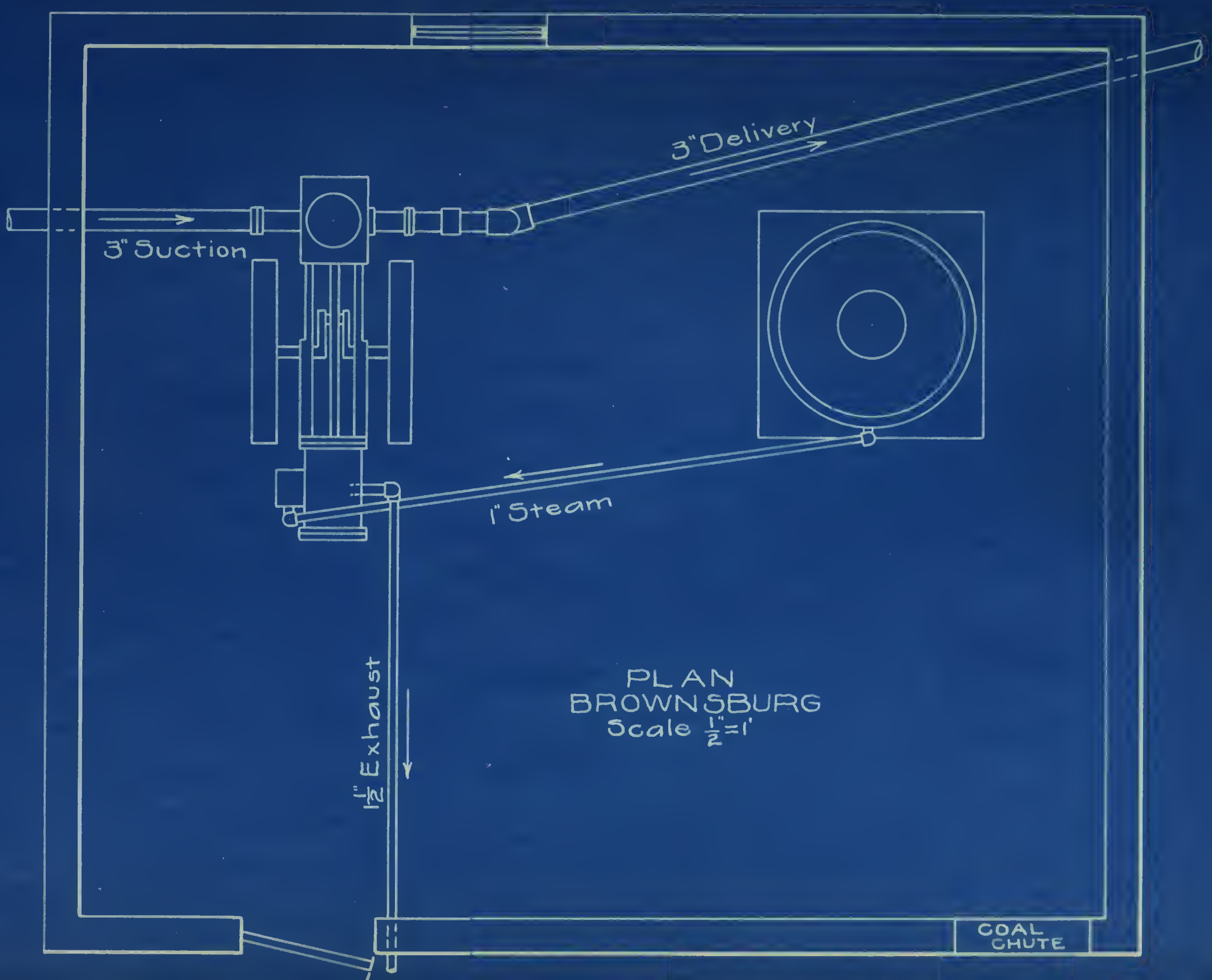
### DATA RELATING TO INSPECTION OF PLANT.

| | |
|---|---|
| Date of Installation | 1896. |
| Date of Inspection | Dec. 15, 1899. |
| Make of Pump | F. M. & Co. |
| Size of pump - Double Acting | 6" x 5"·10". |
| Number of hours per day pump is in operation | 5. |
| Height of Suction | |
| Height og Discharge | |
| Size of Tank | 24' x 16'. |
| Distance of pump house from station | 200 ft. |

# # # # # # # # # # #

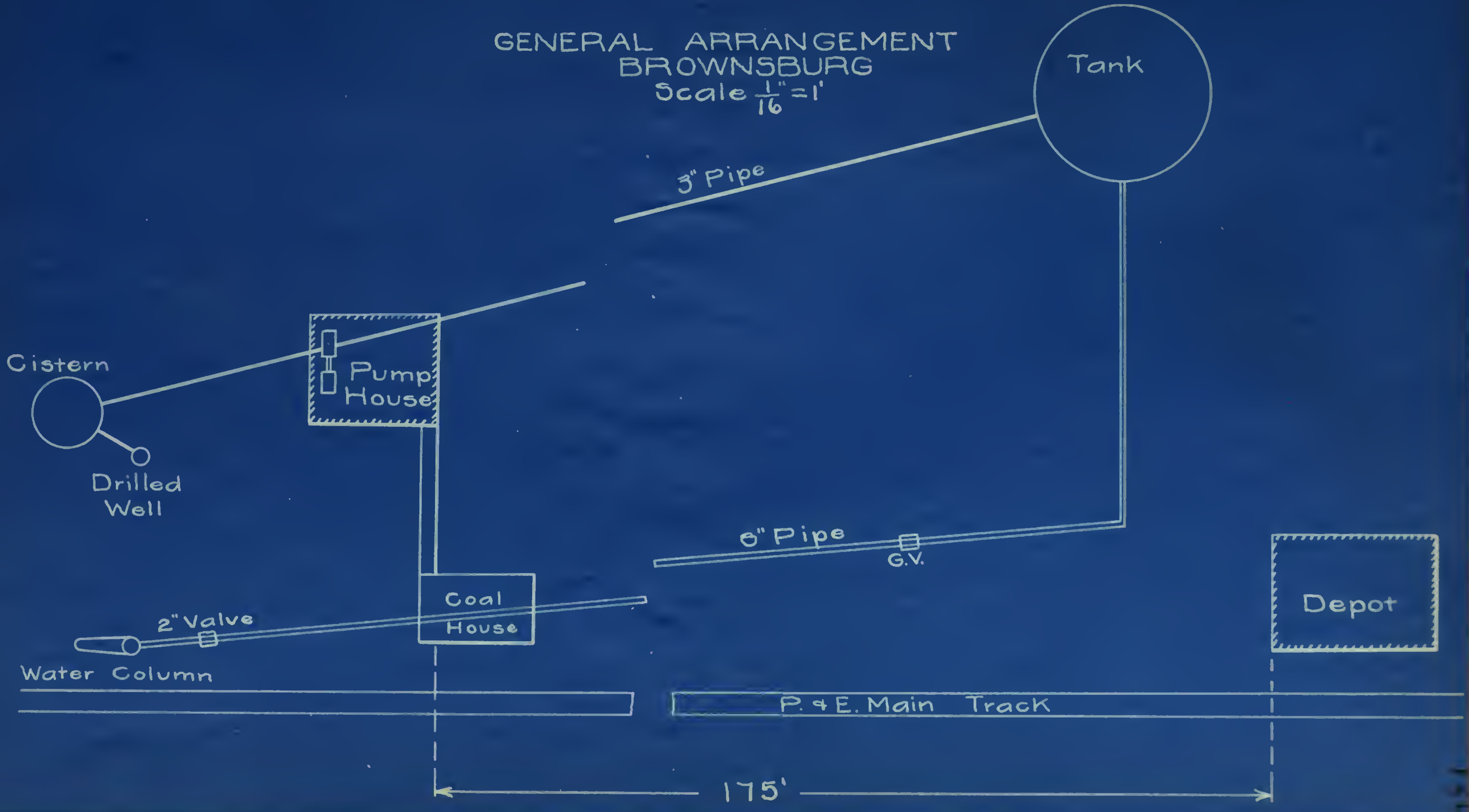
### REMARKS.

This station would be a good place to install a gasoline engine. The pump house is very near the station and there is so little water pumped that a gasoline equipment would be practical.



PLAN
BROWNSBURG
Scale $\frac{1}{2}$"=1'

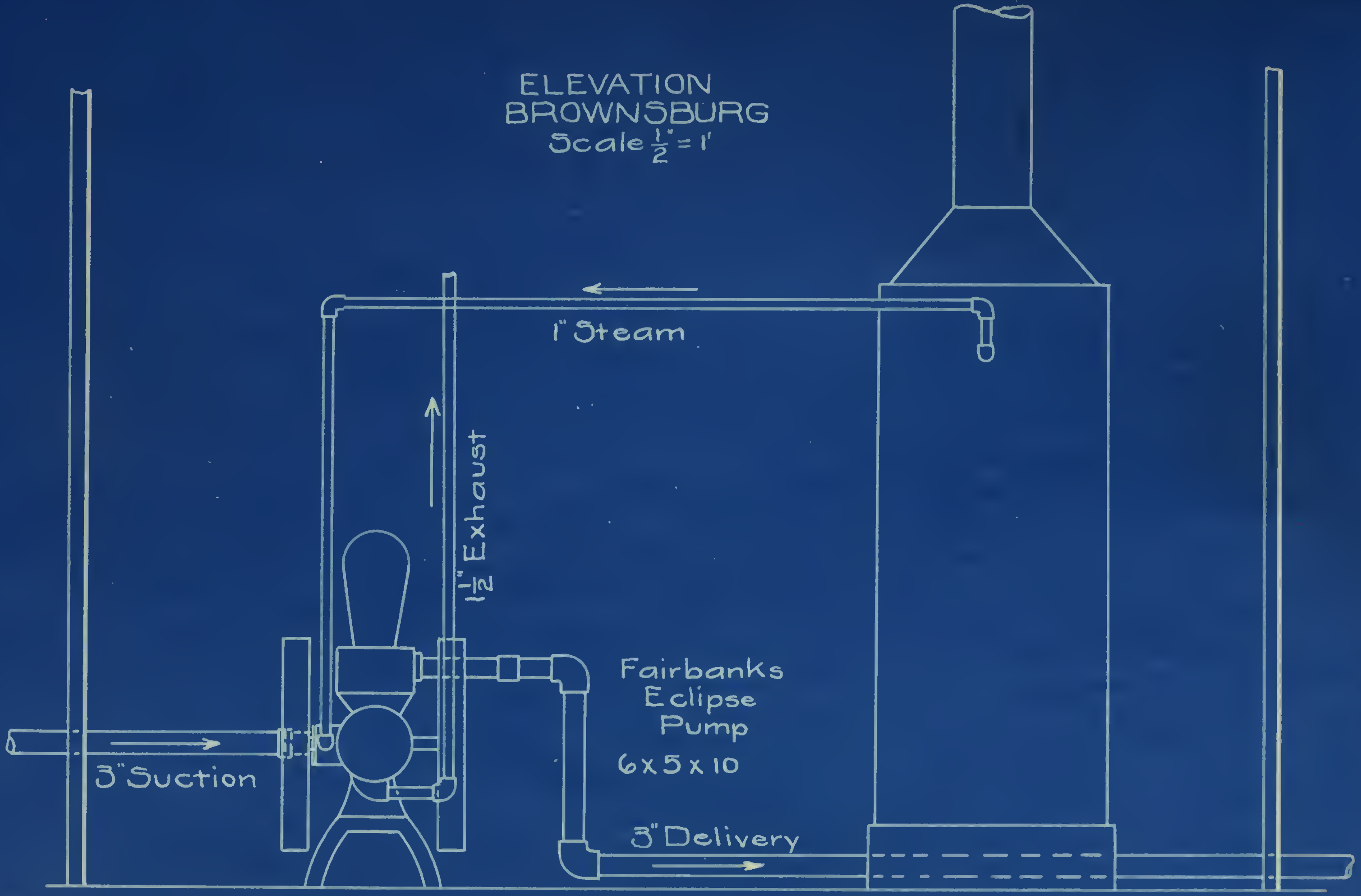
3" Suction
3" Delivery
1" Steam
1½" Exhaust
COAL CHUTE



GENERAL ARRANGEMENT
BROWNSBURG
Scale $\frac{1}{16}'' = 1'$

Tank
3" Pipe
Cistern
Pump House
Drilled Well
6" Pipe
G.V.
Coal House
Depot
2" Valve
Water Column
P. & E. Main Track
175'

ELEVATION
BROWNSBURG
Scale $\frac{1}{2}$" = 1'


1" Steam
$1\frac{1}{2}$" Exhaust
Fairbanks Eclipse Pump
6 x 5 x 10
3" Suction
3" Delivery

Brownsburg

MOORFIELD, INDIANA.

WATER STATION ON THE PEORIA

AND EASTERN RAILWAY.

## MOORFIELD, ILLINOIS.

### DATA RELATING TO THE CO-EFFICIENT OF DISCHARGE TEST .

| | |
|---|---|
| Method Number | 2. |
| Pressure on Pump | 35 lbs. |
| Average number of strokes per min. | 28. |
| Piston speed per min. | 46. |
| Duration of Test | 1 hr. |
| Theoretical discharge per hour | 16885 gals. |
| Actual discharge per hour | 16346 gals. |
| Co-efficient of discharge | 96.7 % |

# # # # # # # ## # #

# MOORFIELD, ILLINOIS.

## RESULTS OF TESTS AND INSPECTION.

| | |
|---|---|
| Water pumped per day | 163460 gals. |
| Work performed per day in lifting water | 111988056 ft. lbs. |
| Work performed from one pound of coal | 73013 ft. lbs. |
| Coal consumed per day | 1533 lbs. |
| Coal consumed per 1000 gals. of water | 9.4 lbs. |
| Coal consumed per month | 45990 lbs. |

# # # # # # # # # # #

## MOORFIELD, INDIANA.

### DATA FROM INSPECTION OF PLANT.

| | |
|---|---|
| Date of Installation | 1900. |
| Date of Inspection | Jan. 3, 1901. |
| Date of Test | Jan. 3, 1901. |
| Make of Pump | Dean. |
| Duties of Pumpman outside of the pump house | Has charge of Boiler House. |
| Number of hours per day pump is in operation | 10. |
| Height of Suction | 14~~15~~ ft. |
| Height of Discharge | 82 ft. |
| Size of Tank | 30' x 20'. |

# # # # # # # # # # #

### REMARKS.

The number of foot pounds of work done per pound of coal is assumed to be the same at this station as at Urbana and all figured were computed from that test. The steam is furnished this plant from a boiler which also furnishes steam for the shops.

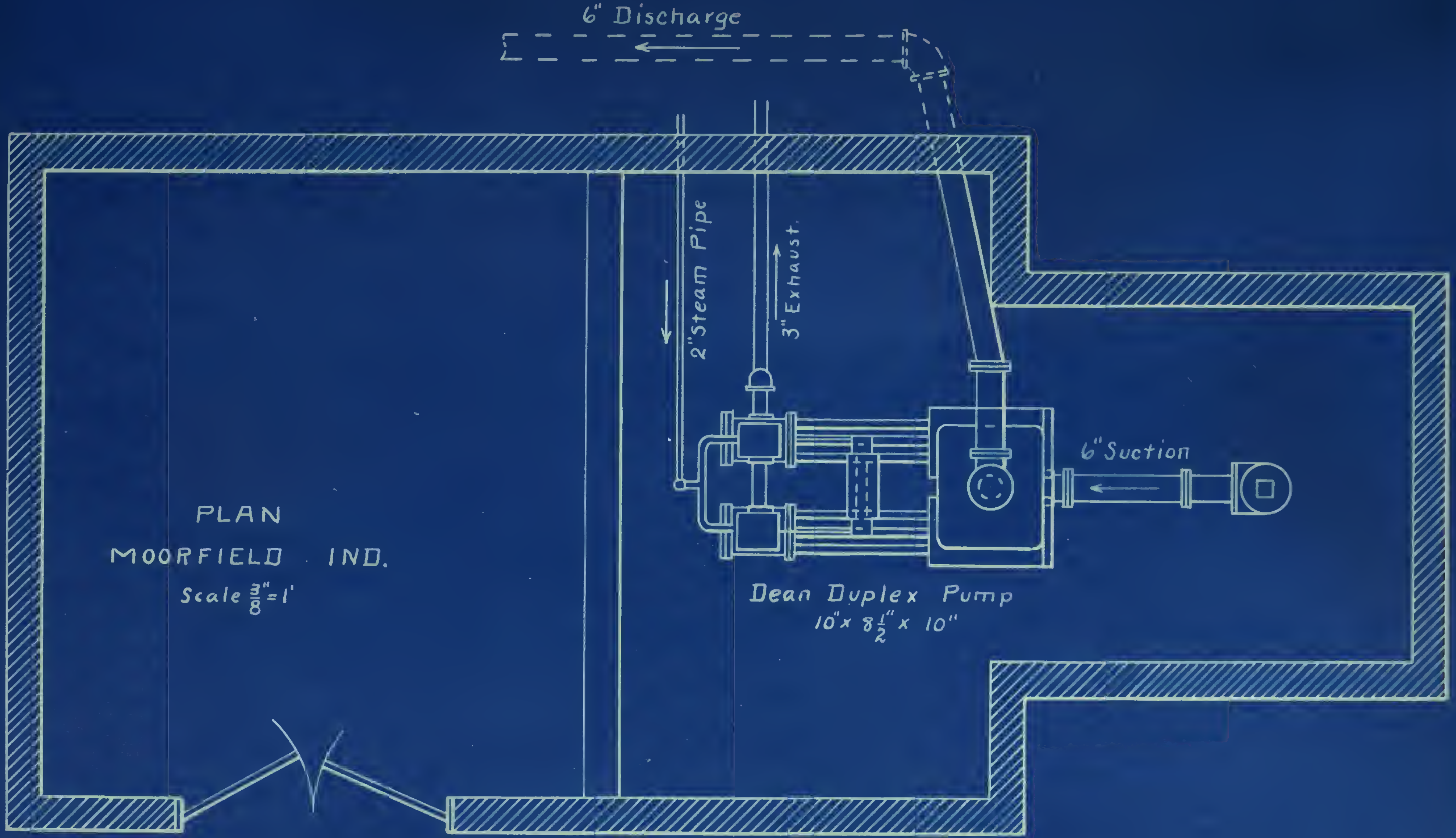
The pump is a new pump and the results show it was in the best of condition.

## MOORFIELD, INDIANA.

### RESULTS OF ESTIMATES ON COSTS.

| | |
|---|---|
| Cost of plant complete | $7574.00 |
| Cost of repairs per month at 2 % per year | 12.62 |
| Amount of depreciation of plant per month at 5 % per year | 31.55 |
| Interest on investment per month at 5 % per year | 31.55 |
| Cost of labor per month | 25.00 |
| Cost of supplies per month | 5.00 |
| Cost of coal per month at $1.10 per ton | 25.29 |
| Total cost of pumping per month | 131.01 |
| Total cost of pumping 1000 gallons | .027 |
| Cost of coal consumed in pumping 1000 gallons | .00517 |

# # # # # # # # # # #



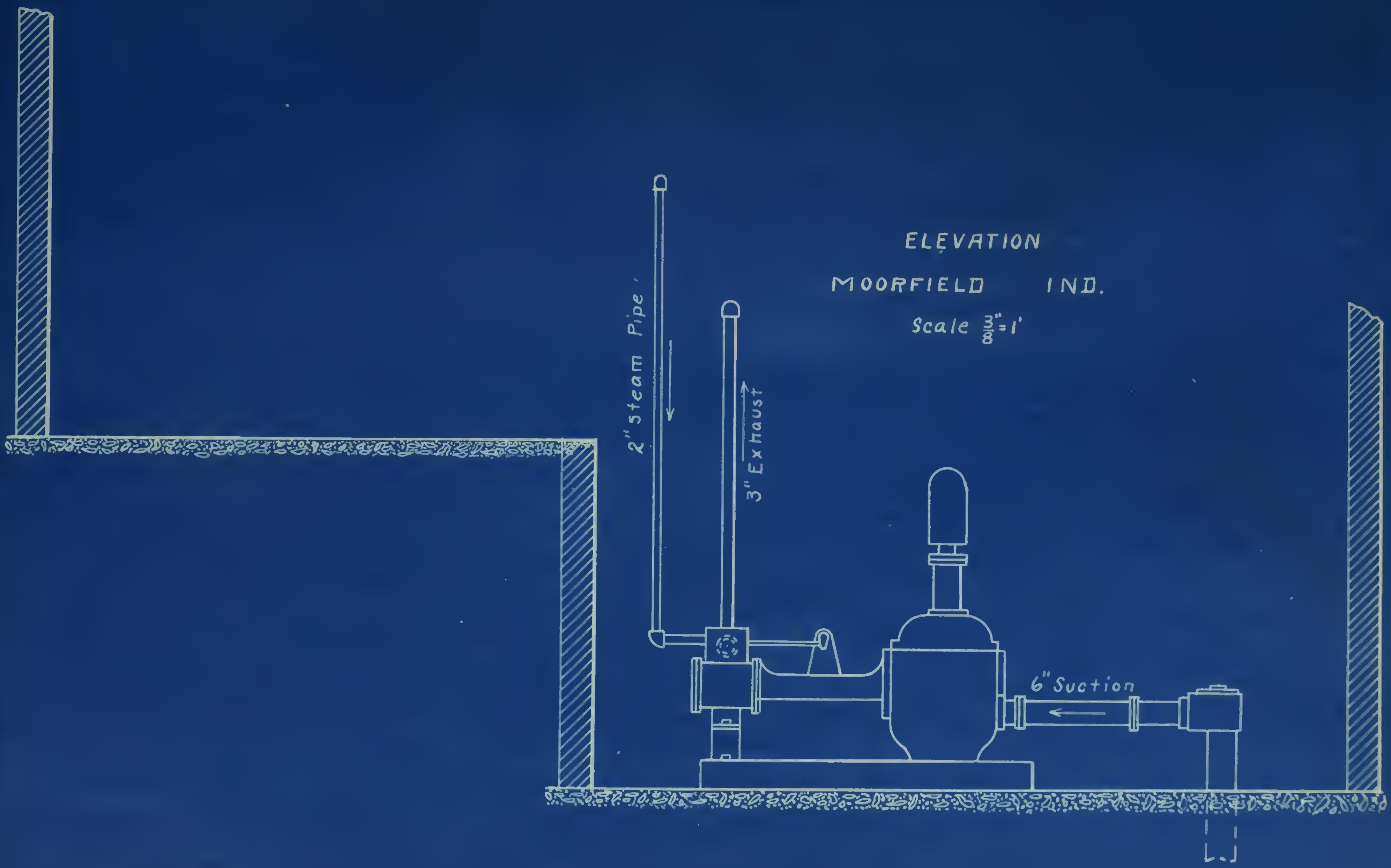
PLAN
MOORFIELD IND.
Scale $\frac{3}{8}" = 1'$

6" Discharge
2" Steam Pipe
3" Exhaust.
6" Suction
Dean Duplex Pump
10" x 8½" x 10"

## ELEVATION

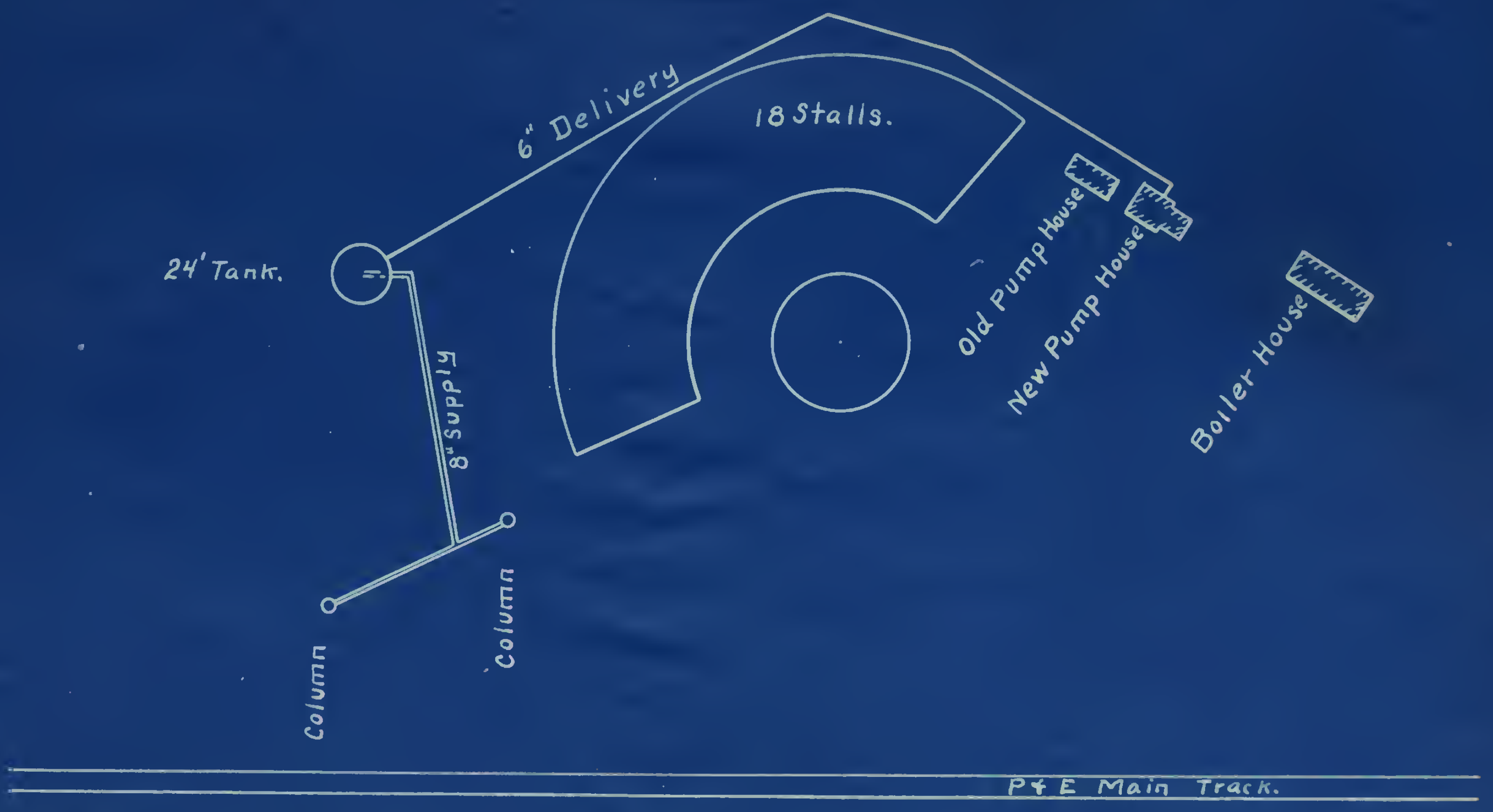
MOORFIELD IND.

Scale $\frac{3}{8}$" = 1'


2" Steam Pipe
3" Exhaust
6" Suction

# GENERAL ELEVATION
# MOORFIELD IND.

Scale 1" = 40'


6" Delivery
18 Stalls.
24' Tank.
8" Supply
Column
Column
Old Pump House
New Pump House
Boiler House
P & E Main Track.

Moorefield

# MAXWELL, INDIANA.

## WATER STATION ON THE PEORIA
## AND
## EASTERN RAILROAD.

## MAXWELL, INDIANA.

### DATA FROM INSPECTION OF PLANT.

| | |
|---|---|
| Date of Installation | 1897. |
| Date of Inspection | Dec. 13, 1900. |
| Date of Test | Dec. 13, 1900. |
| Make of Pump | Cook. |
| Size of Pump | 9" x 5 1/2" x 36". |
| Number of Hours per Day Pump is in Operation | 5. |
| Depth of Well | 219 ft. |
| Height of Discharge - i.e.- From top of water in well to top of tank | 65 ft. |
| Size of Tank | 24' x 16'. |

# # # # # # # # # # #

## MAXWELL, INDIANA.

### DATA RELATING TO THE CO-EFFICIENT OF DISCHARGE TEST.

| Test Number | 1. | 2. |
|---|---|---|
| Method Number | 2. | 2. |
| Average boiler pressure | 56 lbs. | 53 lbs. |
| Average pressure head on pump | 18 lbs. | 18 lbs. |
| Average number of strokes per min. | 22. | 21.8 |
| Piston speed ft. per min. | 142. | 130.8 |
| Theoretical discharge per hour | 4889 gals. | 4851 gals. ~~gles.~~ |
| Actual discharge per hour | 3950 gals. | 4137.9 gals. |
| Co-efficient of dischagge | 80.8 % | 85.3 % |
| Duration of test | 1 hr. 20 min. | 1 hr. 1 1/2 min. |

# # # # # # # # # # #

| | |
|---|---|
| Average actual discharge per hour | 4043 gals. |
| Average co-efficient of discharge | 83.5 % |

## MAXWELL, INDIANA.

### RESULTS OF TESTS AND INSPECTION.

| | |
|---|---|
| Water pumped per day | 20215 gallons. |
| Work performed per day | 10978241 ft. lbs. |
| Work performed from one pound of coal (Mackinaw Test) | 49780 ft. lbs. |
| Coal consumed per day | 220 lbs. |
| Coal consumed per 1000 gals. of water pumped | 11 lbs. |
| Coal consumed per month | 6600 lbs. |

# # # # # # # # # # #

### REMARKS.

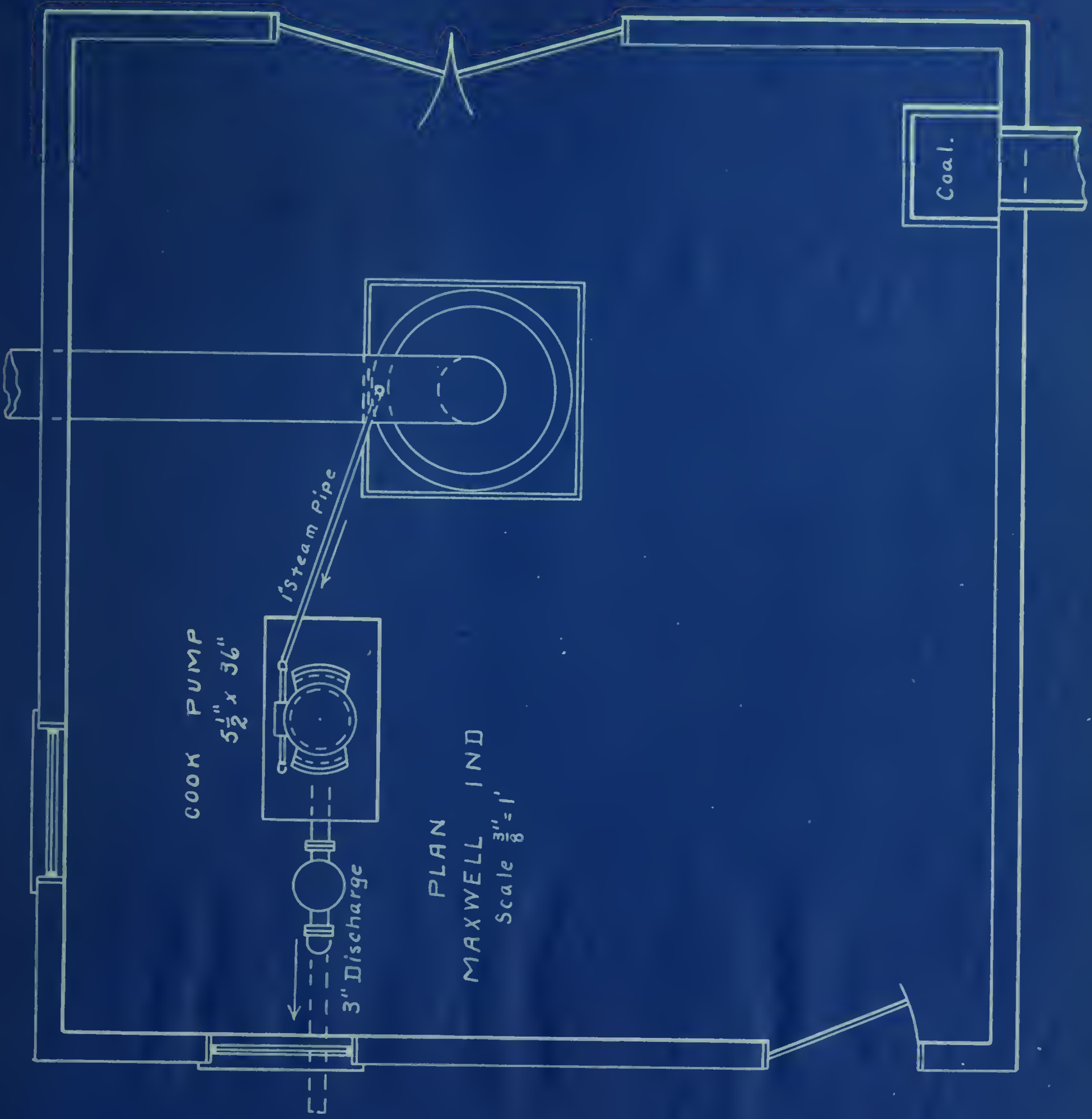
Natural gas is abundant at this station and a 20 Horse Power gas engine is used in an elevator near the station. The cost for gas used by this engine is only $1.50 per month. At the same rate in pumping it would cost you only $.0025 for every 1000 gallons of water pumped. This cost is far below that of coal and it would be advisable to install an engine here, even if you still kept the pumpman.

## MAXWELL, INDIANA.

## RESULTS OF ESTIMATES ON COSTS.

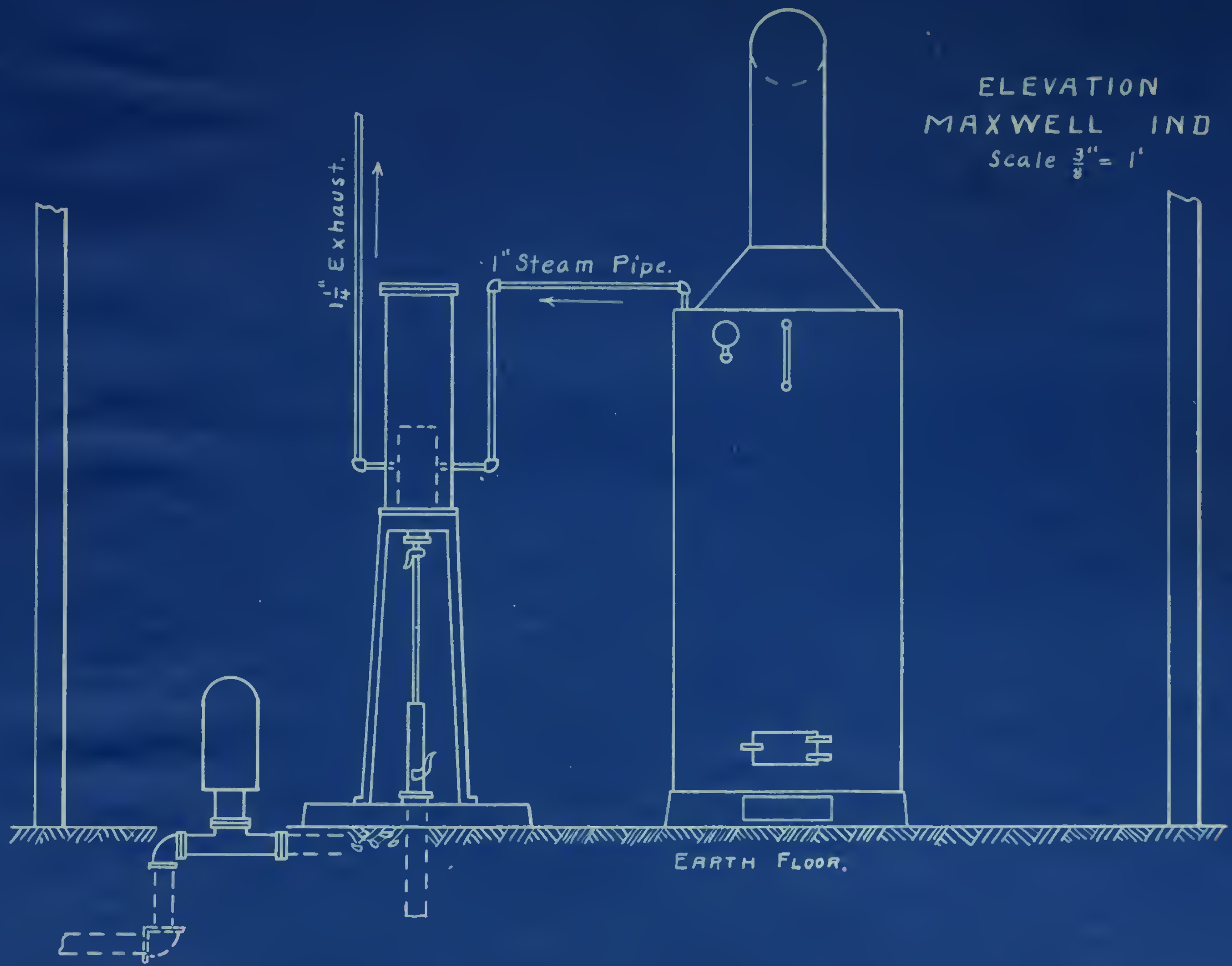
| | |
|---|---|
| Cost of plant complete | $5894.00 |
| Cost of repairs per month | ~~9.82~~ |
| at rate of 2 % per year | 9.82 |
| Amount of depreciation of plant per month | |
| at rate of 5 % per year | 24.55 |
| Interest on investment per month | |
| at 5 % per year | 24.55 |
| Cost of labor per month | 20.00 |
| Cost of supplies per month | 5.00 |
| Cost of coal per month at $1.10 per ton | 3.66 |
| Total cost of pumping per month | 87.55 |
| Total cost of pumping 1000 gallons | .128 |
| Cost of coal consumed in pumping 1000 gallons | .006 |

# # # # # # # # # # #


Coal.
1" Steam Pipe
COOK PUMP
$5\frac{1}{2}" \times 36"$
3" Discharge

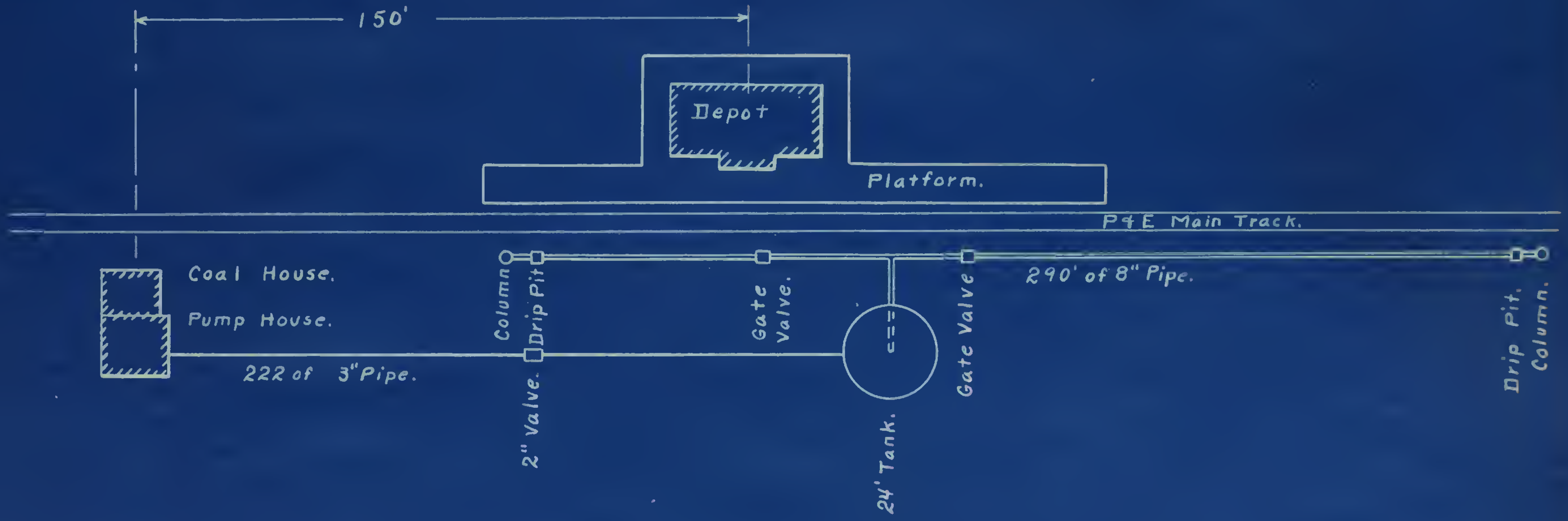
PLAN
MAXWELL IND
Scale $\frac{3}{8}" = 1'$

ELEVATION
MAXWELL IND
Scale $\frac{3}{8}$" = 1'

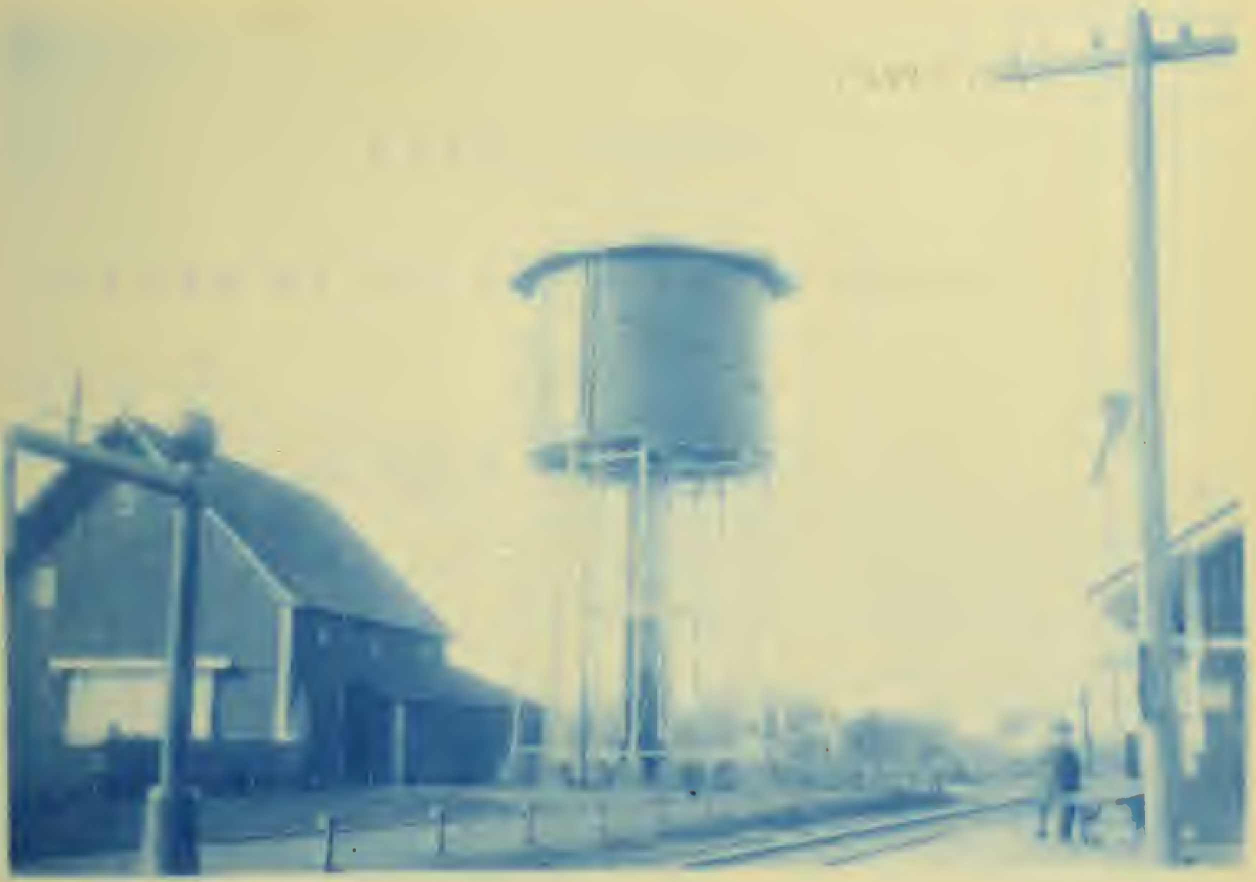

1" Steam Pipe.
$1\frac{1}{4}$" Exhaust.
EARTH FLOOR.

## GENERAL PLAN
## MAXWELL IND

Scale $\frac{3}{8}'' = 1'$


150'
Depot
Platform.
P & E Main Track.
Coal House.
Pump House.
222 of 3" Pipe.
Column
Drip Pit
2" Valve.
Gate Valve.
24' Tank.
Gate Valve
290' of 8" Pipe.
Drip Pit.
Column.

Max well.



Maxwell.

# LYNN, OHIO.

# WATER STATION ON THE PEORIA
# AND
# EASTERN RAILWAY.

## LYNN, OHIO.

## RESULTS OF ESTIMATES.

| | |
|---|---|
| Average strokes per minute | 41. |
| Theoretical discharge per hour | 5018 gals. |
| Assumed co-efficient of discharge which is an average of the tests on Eclipse pumps | 86.9 % |
| Actual dischagge per hour | 4360 gals. |
| Water pumped per day from above estimates | 34880 gals. |
| Work performed per day in lifting water | 17485344 ft. lbs. |
| Work performed per pound of coal, assumed to be the same as Pekin Test | 31780 ft. lbs. |
| Coal burned per day estimated from above | 549 lbs. |
| Coal burned per month | 16470 lbs. |
| Coal used per 1000 gals. of water pumped | 16.1 lbs. |

###########

## LYNN, OHIO.

### DATA FROM INSPECTION PLANT.

| | |
|---|---|
| Date of Installation | 1896. |
| Date of Inspection | Dec. 10, 1900. |
| Make of Pump | F. M. & Co. |
| Size of Pump - Double Acting | 6" x 5 1/2" x 10". |
| Additional duties of pumpman | He watches a locomotive which stops here over night. |
| Number hours per day pump is in operation | 8. |
| Height of Suction | 13 ft. |
| Height of Discharge | 60 ft. |
| Size of Tank | 24' x 16'. |

# # # # # # # # # # #

### REMARKS.

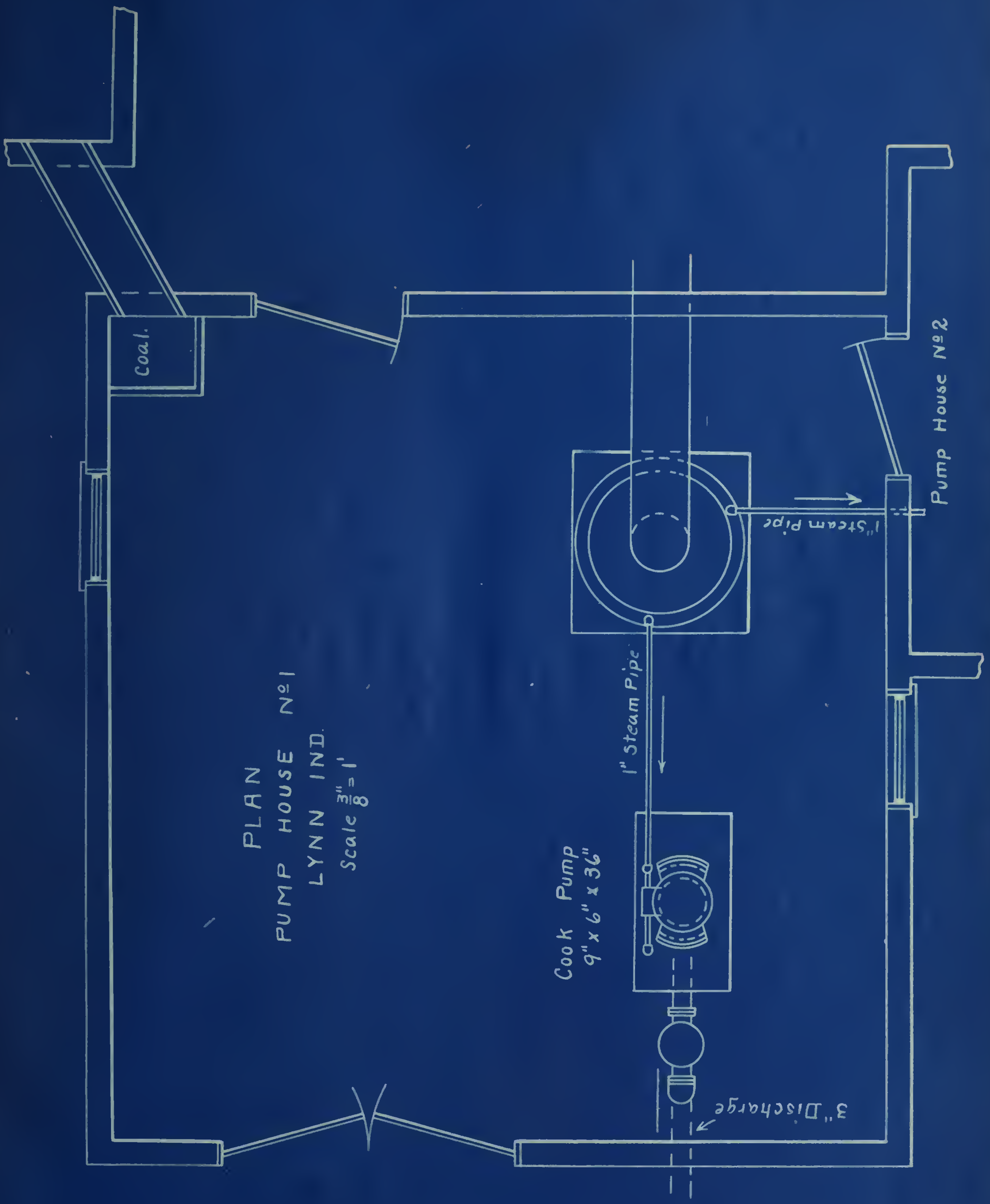
This station is in great need of attention. There has been a large outlay of money here that seems to have accomplished nothing. If a larger pump was located here the pumpman would also do the pumping at Arcanum and thus save a considerable amount each month in pumpman's wages. The amount of work performed per pound of coal is obtained from the Pekin test.

## LYNN, OHIO.

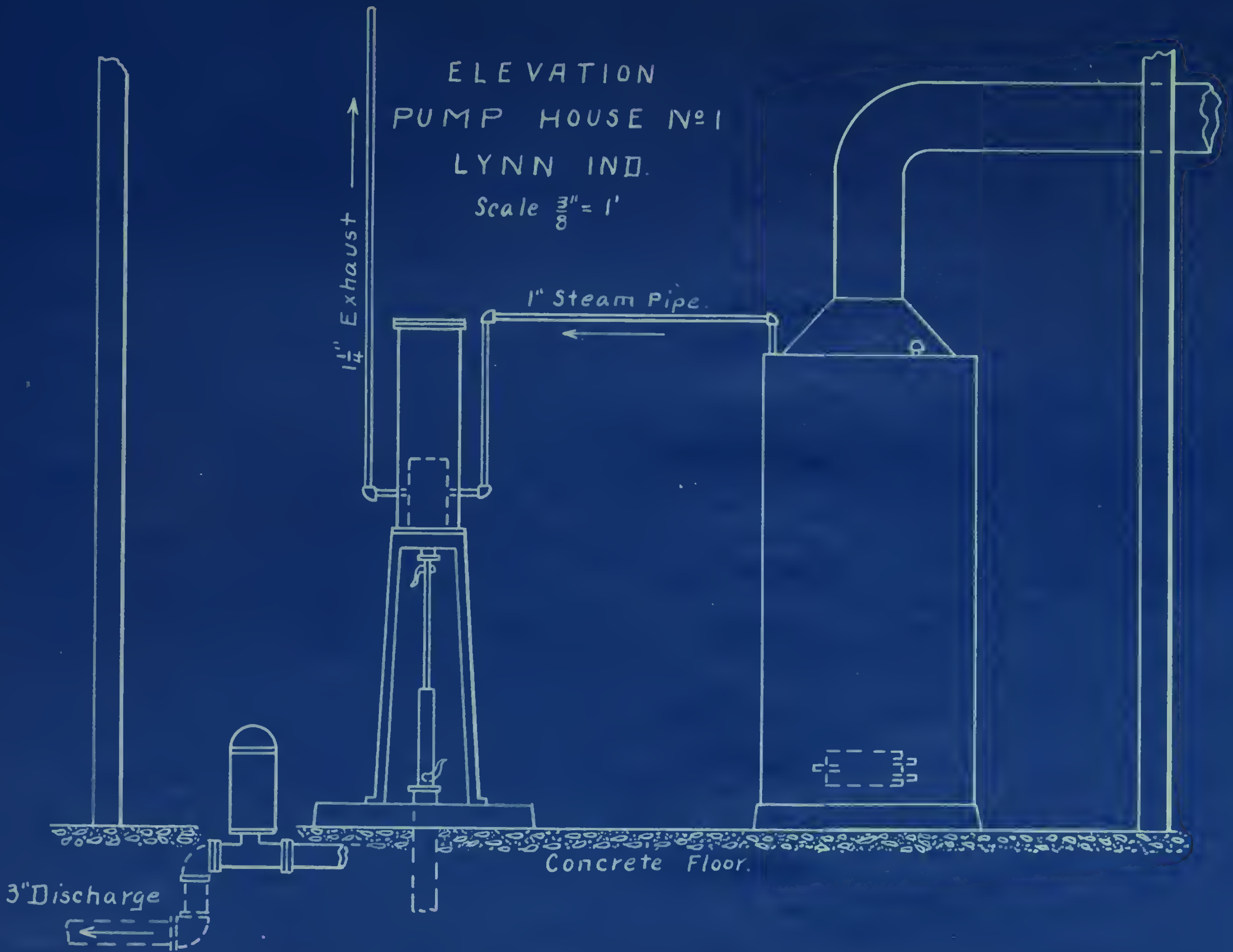
## RESULTS OF ESTIMATES ON COSTS.

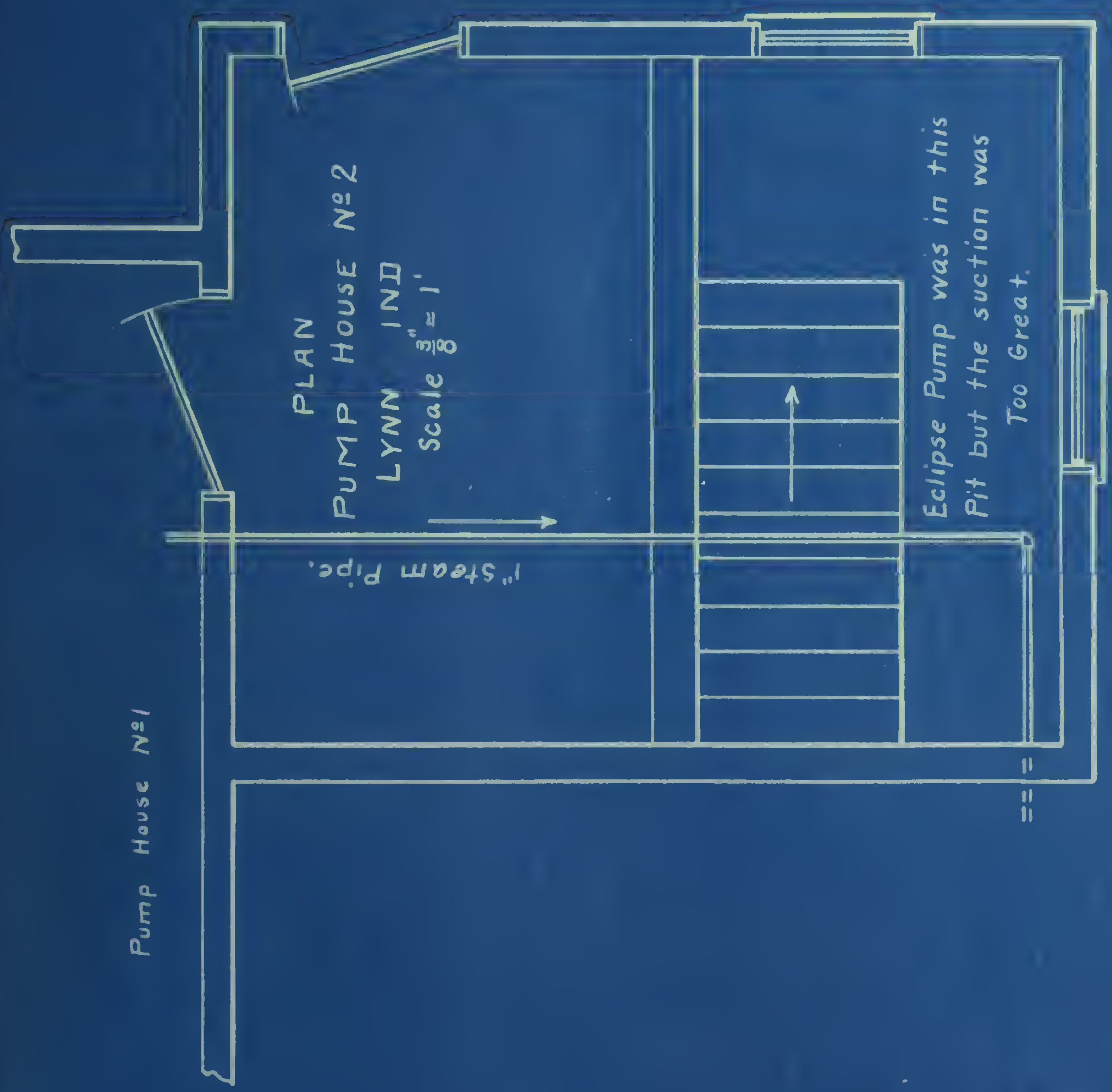
| | |
|---|---|
| Cost of plant | $7229.00 |
| Cost of repairs per month at rate of 2 % per year | 12.04 |
| Amount of Depreciation & Interest on Investment per month rated at 10 % per year | 60.20 |
| Cost of labor per month | 20.00 |
| Cost of supplies per month | 5.00 |
| Cost of coal per month at $1.10 per ton | 9.02 |
| Total cost per month | 106.26 |
| Total cost per 1000 gallons of water pumped | .101 |
| Cost of coal consumed per 1000 gallons of water pumped | .0039 |
| Total cost per month of pumping water if pumpman here also pumped at Arcanum (Wages $15.) | 101.26 |
| Total cost per 1000 gallons with above condition | .097 |

# # # # # # # # # # #


PLAN
PUMP HOUSE No 1
LYNN IND.
Scale 3/8" = 1'
Coal.
Pump House No 2
1" Steam Pipe
1" Steam Pipe
Cook Pump
9" x 6" x 36"
3" Discharge

# ELEVATION
PUMP HOUSE No 1
LYNN IND.
Scale $\frac{3}{8}'' = 1'$


$1\frac{1}{4}''$ Exhaust
1" Steam Pipe.
Concrete Floor.
3" Discharge

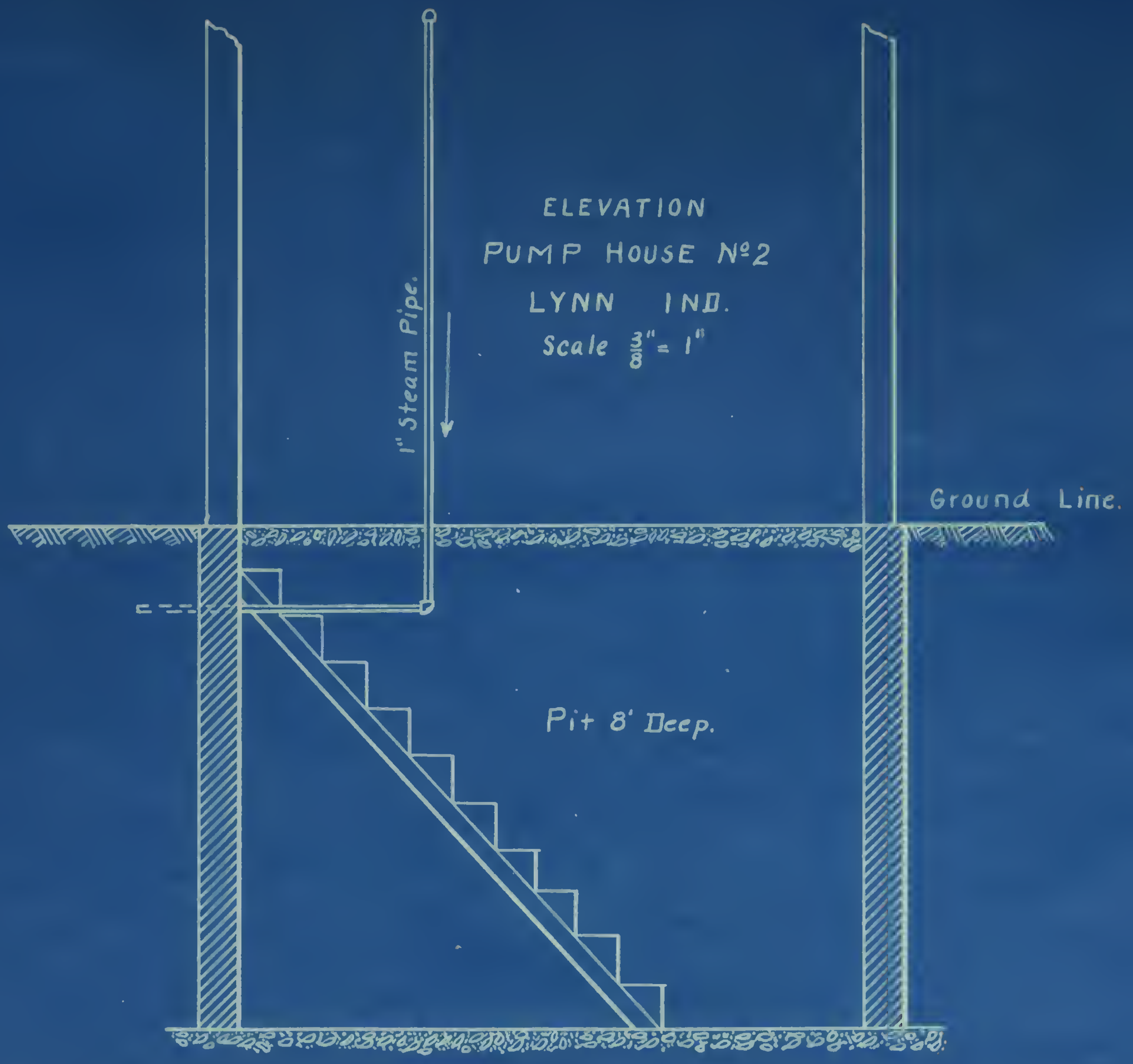


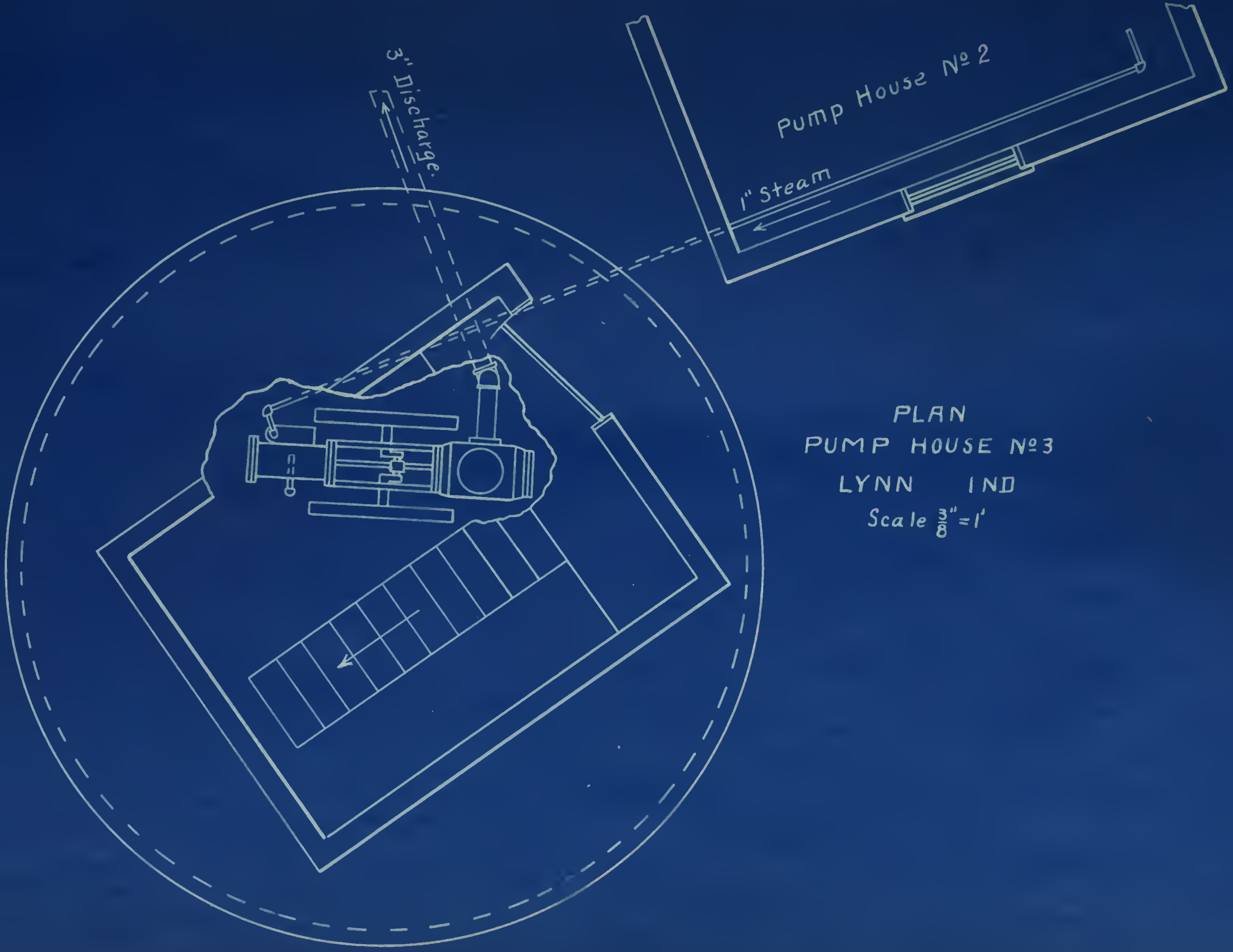
PLAN
PUMP HOUSE No 2
LYNN IND
Scale 3/8" = 1'

Eclipse Pump was in this Pit but the suction was Too Great.

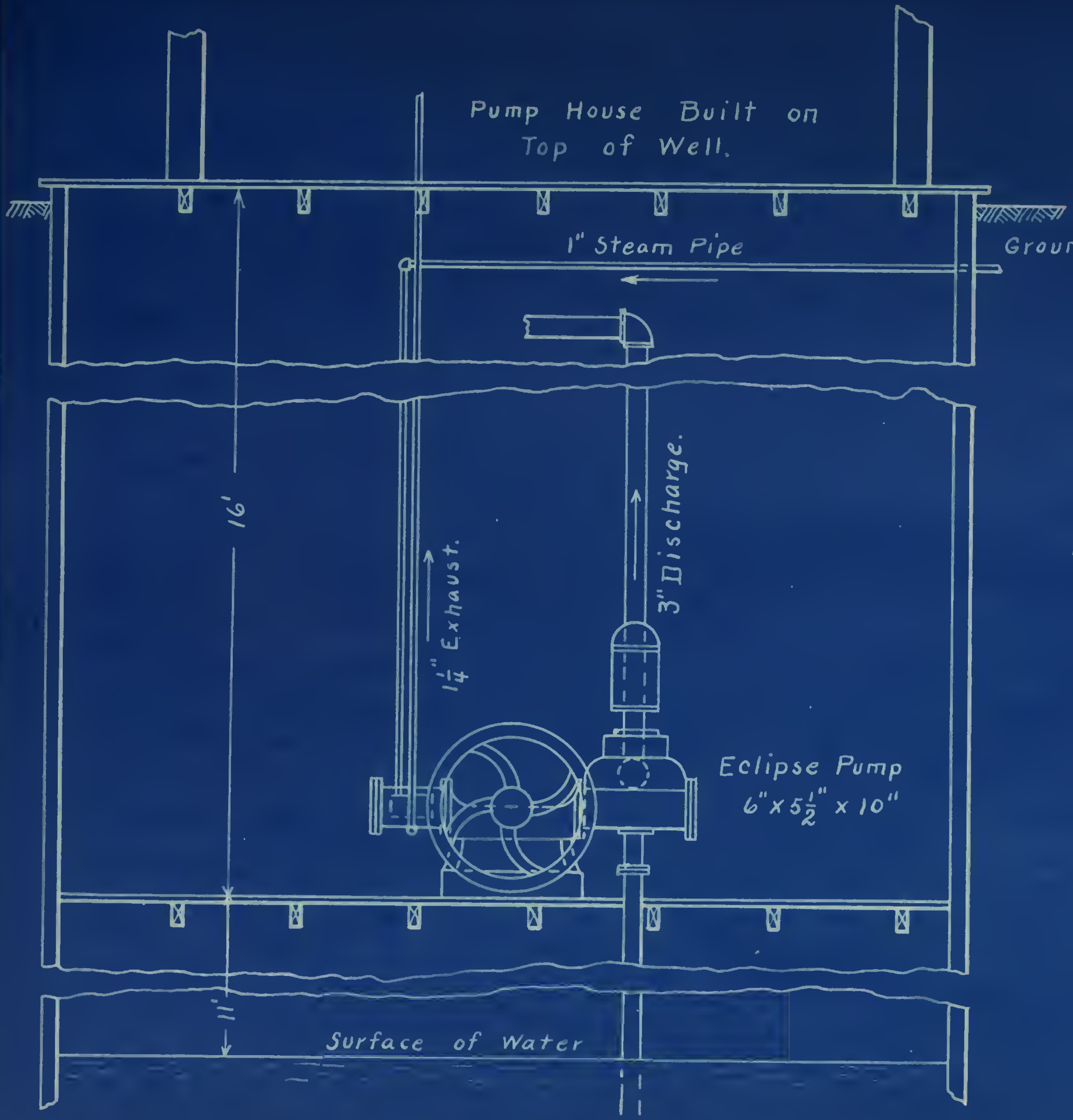
1" Steam Pipe.
Pump House No 1

ELEVATION
PUMP HOUSE No. 2
LYNN IND.
Scale $\frac{3}{8}" = 1"$

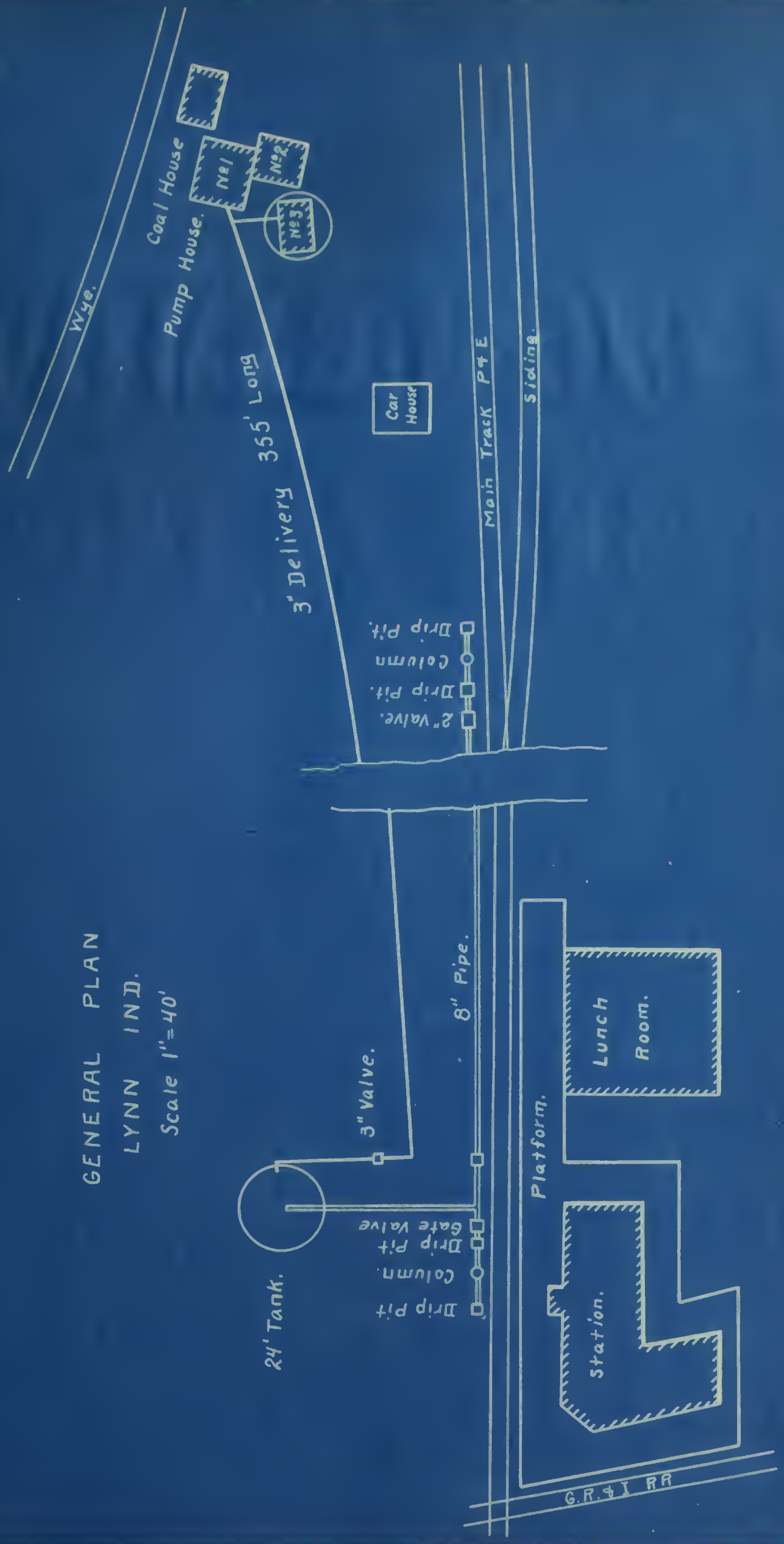

1" Steam Pipe.
Ground Line.
Pit 8' Deep.


3" Discharge.
Pump House No 2
1" Steam

PLAN
PUMP HOUSE No 3
LYNN IND
Scale $\frac{3}{8}"=1'$


Pump House Built on
Top of Well.
1" Steam Pipe
Ground Line.
16'
$1\frac{1}{4}$" Exhaust.
3" Discharge.
Eclipse Pump
6" x $5\frac{1}{2}$" x 10"
11'
Surface of Water

ELEVATION
PUMP HOUSE No 3
LYNN IND
Scale $\frac{3}{8}$" = 1'



GENERAL PLAN
LYNN IND.
Scale 1"=40'

Wye.
Coal House
Pump House.
No1
No2
No3
3" Delivery 355' Long
Car House
Main Track P & E
Siding.
Drip Pit.
Column
Drip Pit.
2" Valve.
8" Pipe.
3" Valve.
24' Tank.
Gate Valve
Drip Pit
Column.
Drip Pit
Platform.
Lunch Room.
Station.
G.R.& I RR

Lynn.

Lynn.

Lynn.

# ARCANUM, OHIO.

# WATER STATION ON THE PEORIA AND EASTERN RAILWAY.

# ARCANUM, OHIO.

## DATA RELATING TO INSPECTION OF PLANT.

| | |
|---|---|
| Date of Installation | 1896. |
| Date of Inspection | Dec. 10, 1900. |
| Date of Test | Dec. 10, 1900. |
| Make of Pump | F. M. & Co. |
| Size of Pump - Double Acting | 6" x 5 7/16" x 10" |
| Distance of Pump House from Depot in ft. | 110. |
| Number of hours per day that pump is in operation | 4. |
| Depth of well in ft. | 17. |
| Height of suction in ft. | 13. |
| Height of discharge in ft. | 48. |
| Size of tank | 24' x 16'. |

# # # # # # # # # # #

# ARCANUM, OHIO.

## DATA RELATING TO THE CO-EFFICIENT OF DISCHARGE TESTS.

| | | |
|---|---|---|
| Test Number | 1. | 2. |
| Method Number | 1. | 1. |
| Average boiler pressure | 53 lbs. | 51 lbs. |
| Average pressure head on pump | 20 lbs. | 20 lbs. |
| Average number of strokes per min. | 84. | 85. |
| Piston speed ft. per min. | 140. | 141. |
| Duration of test | 20 min. | 20 min. |
| Theoretical discharge during test | 3366 gals. | 3430 gals. |
| Actual discharge during test | 3123 gals. | 3069 gals. |
| Co-efficient of discharge | 92.8 % | 89.5 % |
| Theoretical discharge per hour | 10098 gals. | 10290 gals. |
| Actual discharge per hour | 9378 gals. | 9216 gals. |
| Mean velocity head in ft. | 1.042 | 1.026 |
| Size of nozzle used | 3". | 3". |

# # # # # # # # # # #

| | |
|---|---|
| Average actual discharge per hour | 9292 gals. |
| Average co-efficient of discharge | 91.6 % |

# ARCANUM, OHIO.

## RESULTS OF TESTS AND INSPECTION.

| | |
|---|---|
| Water pumped per day | 37168 gals. |
| Work performed per day in lifting water | 14905824 ft. lbs. |
| Work performed per pound of coal | 31780 ft. lbs. |
| Coal burned per 24 hours | 469 lbs. |
| Coal burned per 1000 gals. of water pumped | 12.6 lbs. |
| Coal burned per month | 14070 lbs. |

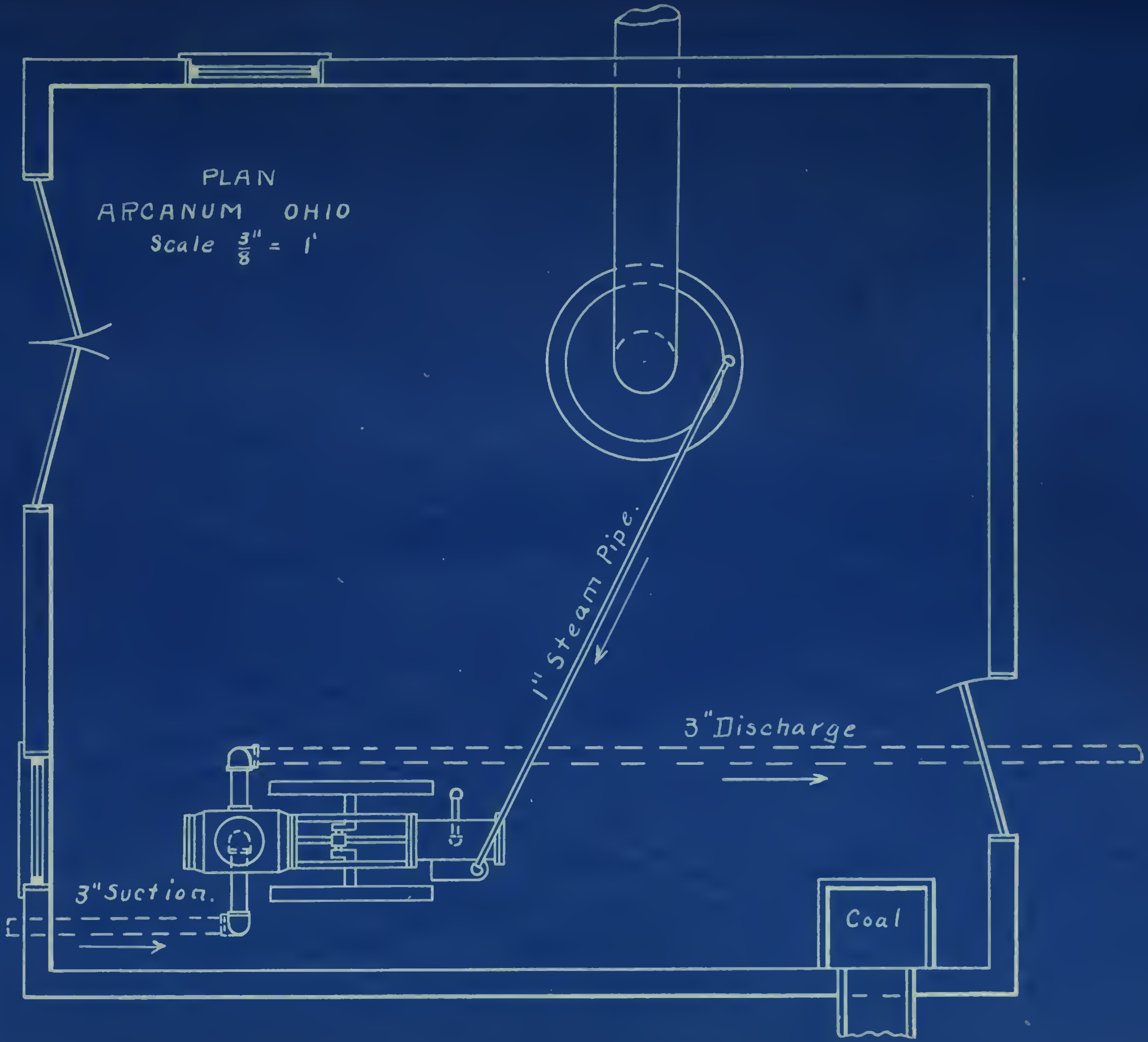
# # # # # # # # # # #

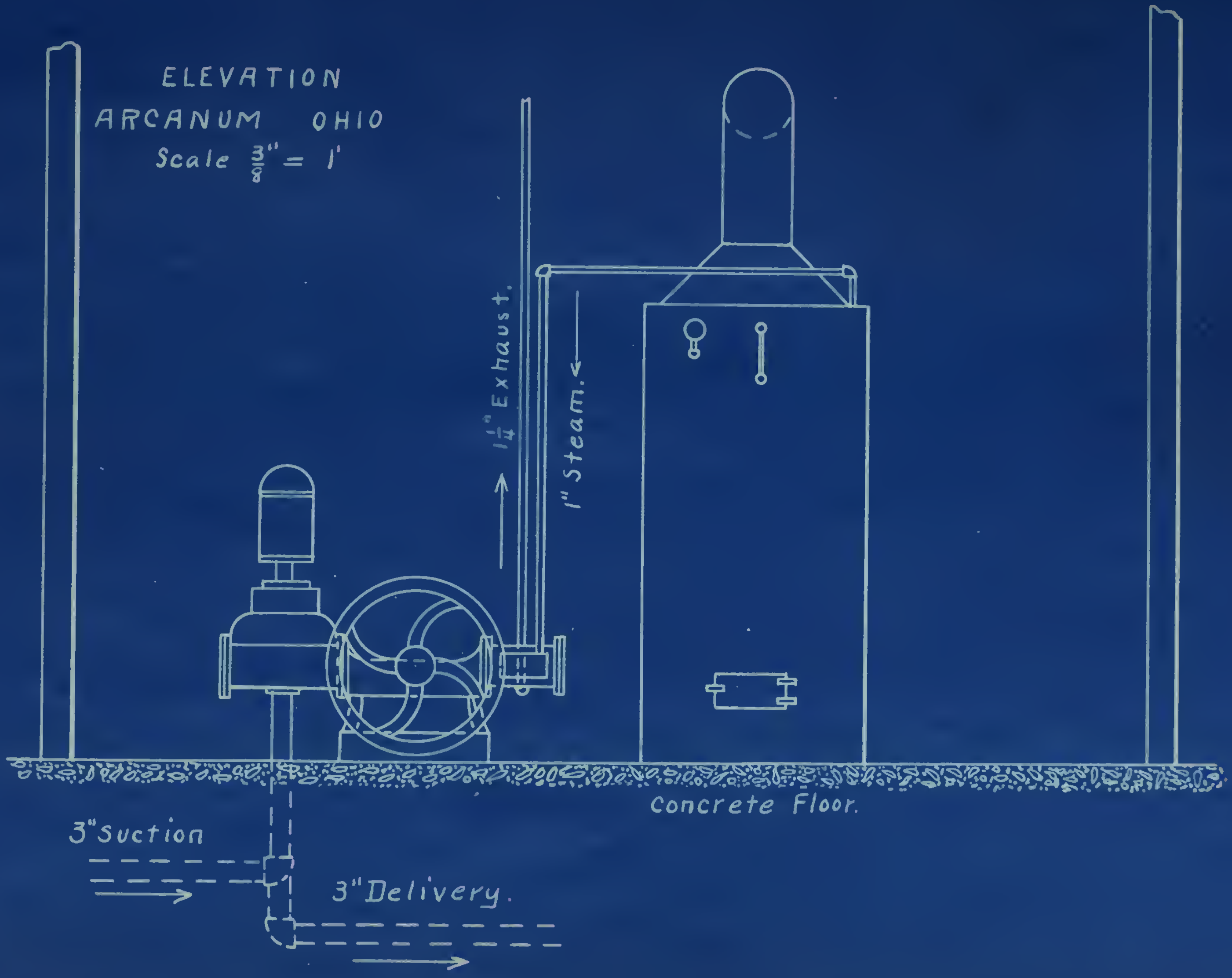
## ARCANUM, OHIO.

### RESULTS OF ESTIMATES ON COSTS.

| | |
|---|---|
| Cost of plant complete | $6185.00 |
| Cost of repairs per month at rate of 2 % per year | 10.31 |
| Amount of depreciation of plant per month at 5 % per year | 25.77 |
| Interest per month at rate of 5 % per year | 25.77 |
| Cost of labor per month | 20.00 |
| Cost of supplies per month | 5.00 |
| Cost of coal per month at $1.10 per ton | 7.73 |
| Total cost of pumping per month | 94.58 |
| Total cost of pumping 1000 gallons | .084 |
| Cost of coal for pumping 1000 gallons | .0069 |
| Total cost of pumping per month if pumpman also pumps at Lynn (Wages $15.) | 89.58 |
| Total cost of pumping 1000 gallons if pumpman also pumps at Lynn | .080 |

# # # # # # # # # # #

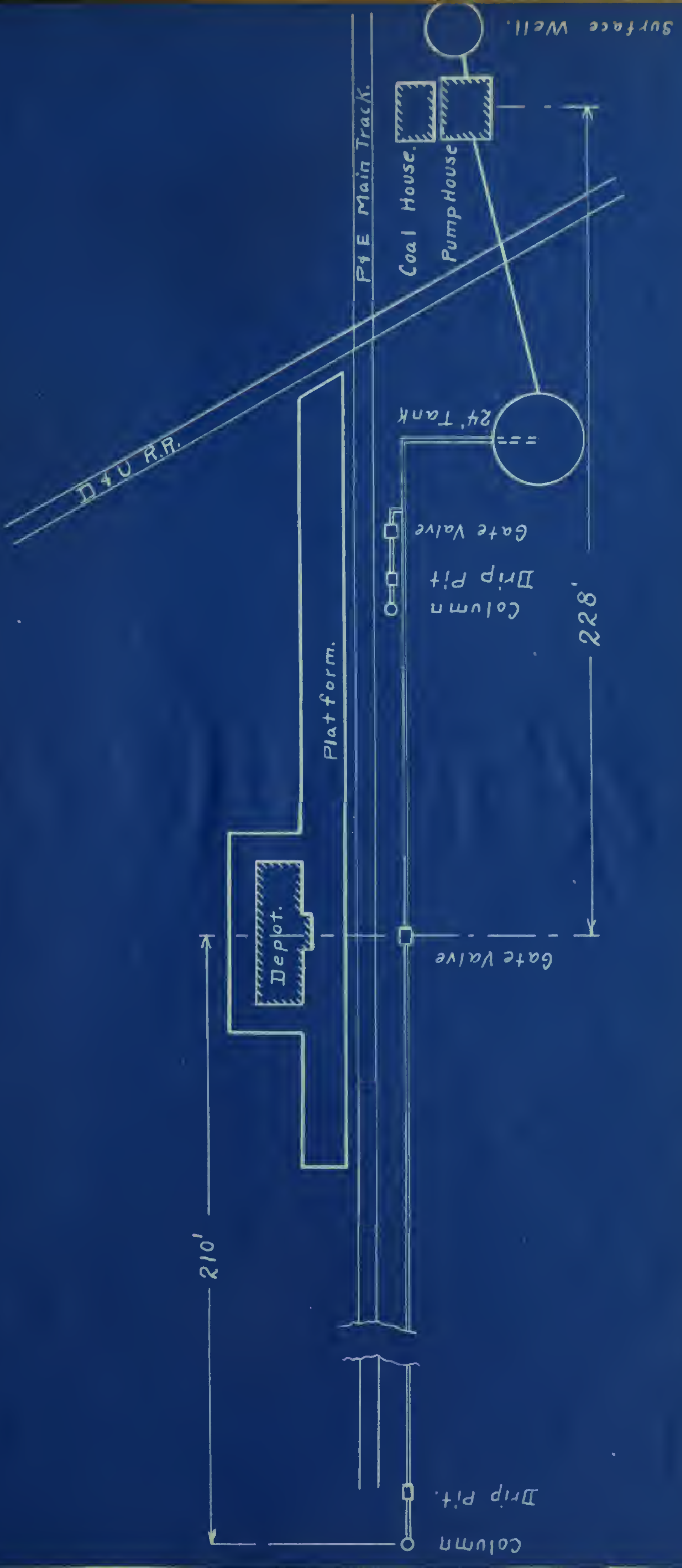

PLAN
ARCANUM OHIO
Scale $\frac{3}{8}$" = 1'
1" Steam Pipe.
3" Discharge
3" Suction.
Coal



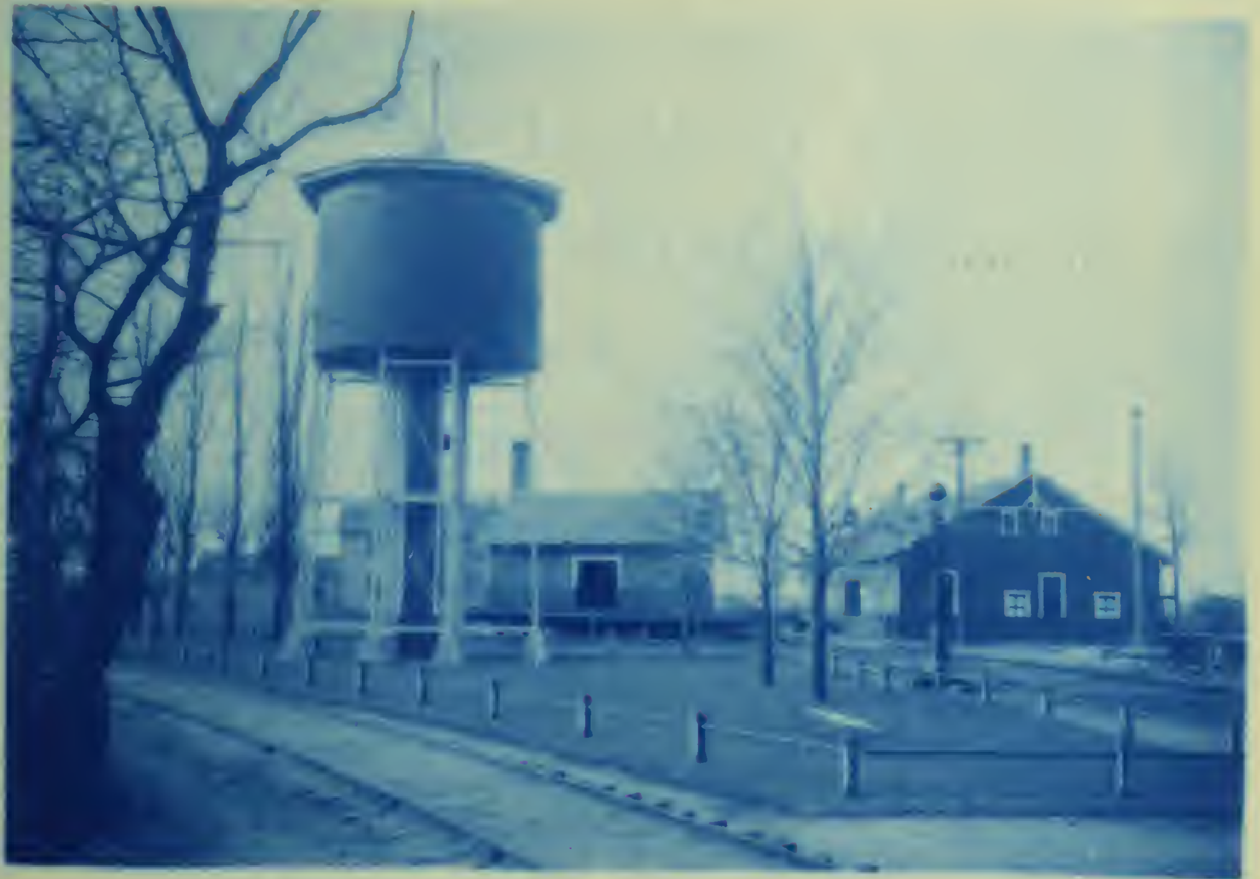
ELEVATION
ARCANUM OHIO
Scale $\frac{3}{8}$" = 1'

$1\frac{1}{4}$" Exhaust.
1" Steam.
Concrete Floor.
3" Suction
3" Delivery.

# GENERAL PLAN
# ARCANUM OHIO
Scale 1" = 40'


Surface Well.
Coal House.
Pump House
P & E Main Track.
D & U R.R.
24' Tank
Gate Valve
Drip Pit
Column
228'
Platform.
Depot.
Gate Valve
210'
Drip Pit.
Column

Arcanum.



Arcanum.

# TROY, OHIO.

# WATER STATION ON THE PEORIA
# AND
# EASTERN RAILWAY.

## TROY, OHIO.

### DATA RELATING TO THE INSPECTION OF PLANT.

| | |
|---|---|
| date of Installation | 1896. |
| Date of Inspection | Dec. 11, 1900. |
| Date of Test | Dec. 11, 1900. |
| Make of Pump | F. M. & Co. |
| Size of Pump - Double Acting | 7 1/8" x 5 5/16" x 10". |
| Distance of pump house from depot | 150 ft. |
| Additional duties of pumpman | Car Inspector. |
| Number of hours per day pump is in operation | 3. |
| Depth of Well | 20 ft. |
| Height of Suction | 17 ft. |
| Height of Discharge | 47 ft. |
| Size of Tank | 24' x 16'. |

# # # # # # # # # # #

# TROY, OHIO.

## DATA RELATING TO THE CO-EFFICIENT OF DISCHARGE TEST.

| | |
|---|---|
| Method Number | 2. |
| Average boiler pressure | 63 lbs. |
| Average pressure head on pump | 20 lbs. |
| Average number of strokes per min. | 60. |
| Duration of test | 38 min. 57 sec. |
| Piston speed ft. per min. | 100. |
| Theoretical discharge during test | 4463 gals. |
| Actual discharge during test | 3944 gals. |
| Co-efficient of discharge | 88.3 % |
| Theoretical discharge per hour | 11440 gals. |
| Actual discharge per hour | 10101 gals. |

# # # # # # # # # # #

# TROY, OHIO.

## RESULTS OF TESTS AND INSPECTION.

| | |
|---|---|
| Water pumped per 24 hrs. | 30303 gals. |
| Work performed in 24 hrs. | 11899507 ft. lbs. |
| Work performed per pound of coal | 31780 ft. lbs. |
| Coal consumed per 1000 gals. of water pumped | 12.3 lbs. |
| Coal burned per day | 373 lbs. |
| Coal burned per month | 11208 lbs. |

###########

## REMARKS.

The pump at this station is the same as the one at Pekin and the amount of work done per pound of coal is taken from the Pekin Test.

The pumpman is car inspector at this station so there would be no object in using a gasoline engine to decrease the cost of attendance.

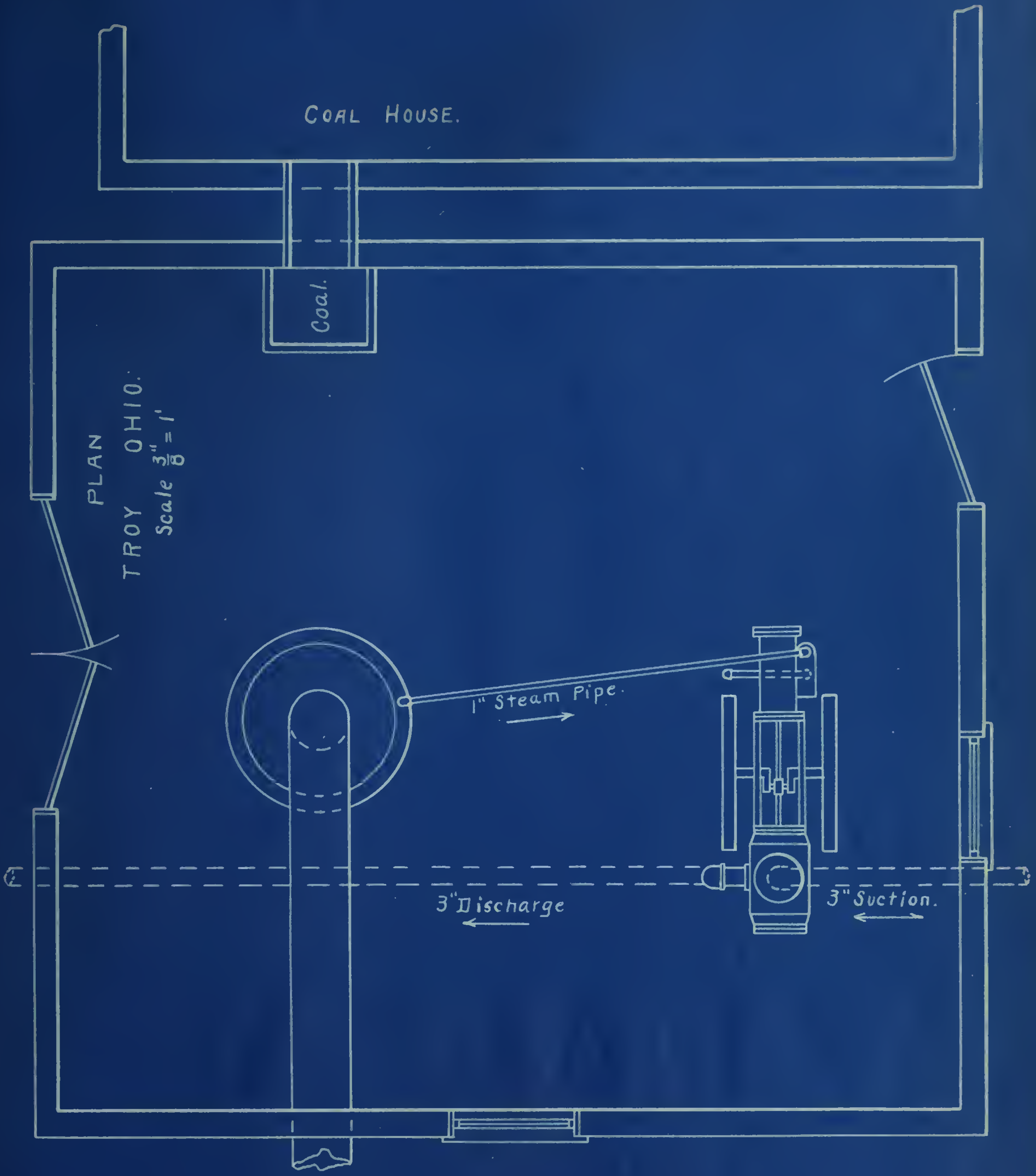
###########

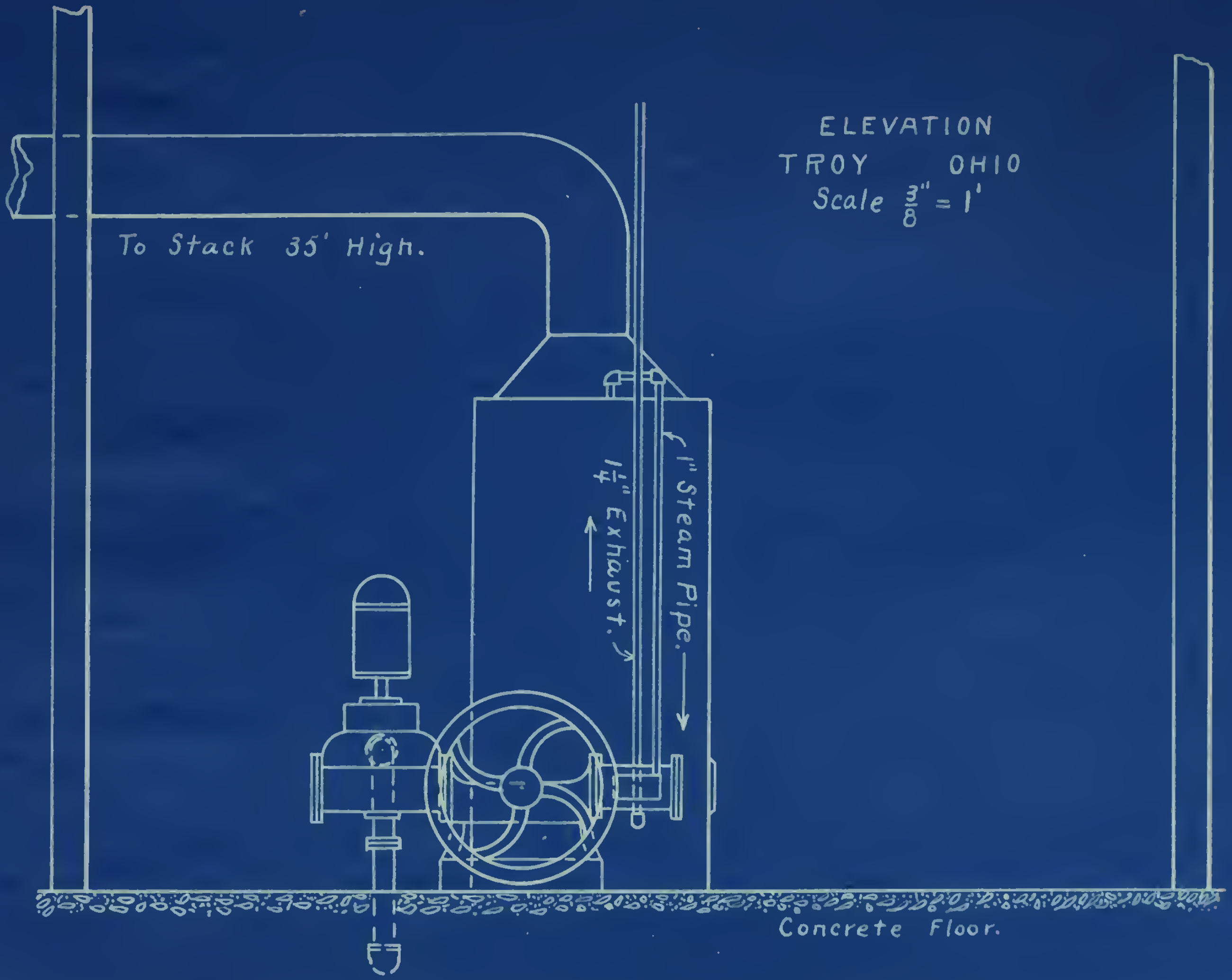
# TROY, OHIO.

## RESULTS OF ESTIMATES ON COSTS.

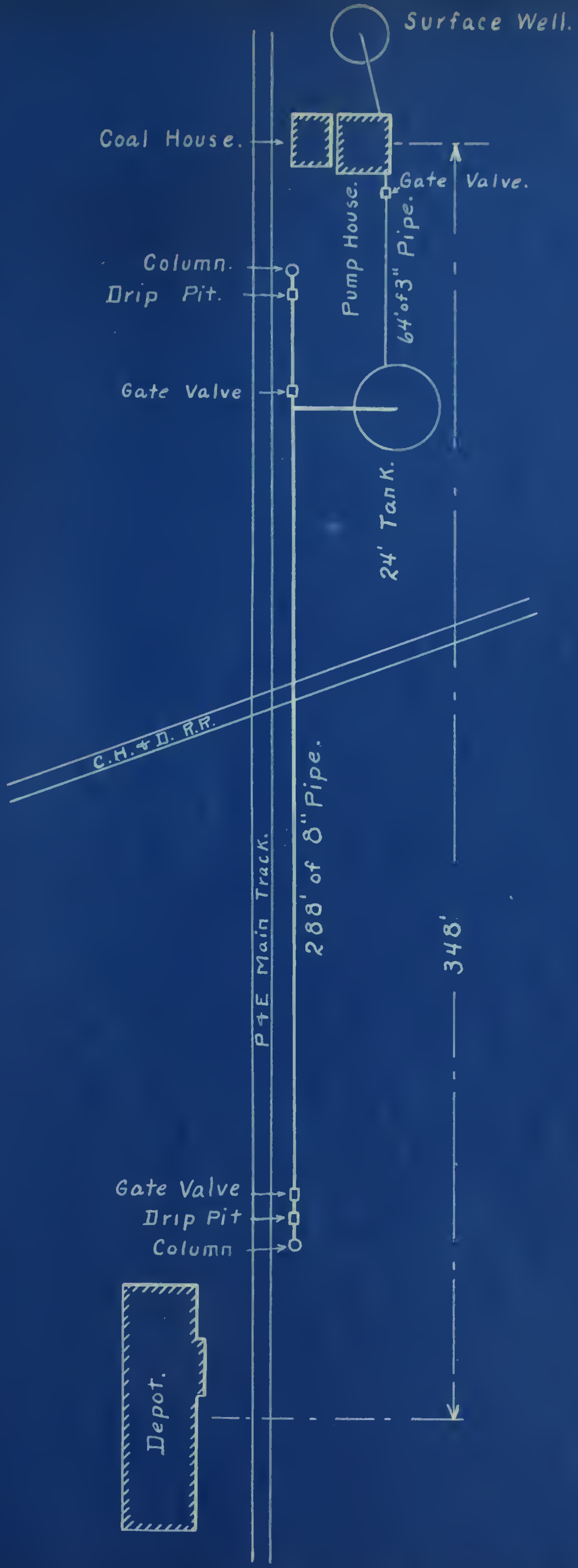
| | |
|---|---|
| Cost of Plant complete | $6473.00 |
| Cost of repairs per month at 2 % per year | 10.89 |
| Amount of depreciation of plant per month at rate of 5 % per year | 26.97 |
| Interest on investment per month at rate of 5 % per year | 26.97 |
| Cost of labor per month | 15.00 |
| Cost of supplies per month | 5.00 |
| Cost of coal per month @ $1.10 per ton | 5.56 |
| Total cost of pumping per month | 90.39 |
| Total cost of pumping 1000 gallons | .099 |
| Cost of coal consumed in pumping 1000 gals. | .0067 |

# # # # # ### # # ##


COAL HOUSE.
Coal.
PLAN
TROY OHIO.
Scale $\frac{3}{8}'' = 1'$
1" Steam Pipe.
3" Discharge
3" Suction.


ELEVATION
TROY OHIO
Scale $\frac{3}{8}$" = 1'
To Stack 35' High.
1" Steam Pipe.
$1\frac{1}{4}$" Exhaust.
Concrete Floor.

GENERAL PLAN
TROY OHIO
Scale 1" = 40'.


Surface Well.
Coal House.
Pump House.
Gate Valve.
64' of 3" Pipe.
Column.
Drip Pit.
Gate Valve
24' Tank.
C.H. & D. R.R.
P & E Main Track.
288' of 8" Pipe.
348'
Gate Valve
Drip Pit
Column
Depot.

Troy.

Troy

# DURBIN, OHIO.

# WATER STATION ON THE PEORIA AND EASTERN RAILWAY.

## DURBIN, OHIO.

### DATA RELATING TO THE INSPECTION OF PLANT.

| | |
|---|---|
| Date of Installation | 1896. |
| Date of Inspection | Dec. 12, 1900. |
| Date of Test | Dec. 12, 1900. |
| Make of Pump | F. M. & Co. |
| Size of Pump - Double Acting | 7" x 5 3/8" x 10". |
| Distance of pump house from Depot | 230 ft. |
| Additional Duties of Pumpman | Car Inspector. |
| Number of hours per day pump is in operation | 3. |
| Depth of Well | 12 ft. |
| Height of Suction | 5 ft. |
| Height of Discharge | 46 ft. 6 in. |
| Size of Tank | 24' x 16'. |

###########

# DURBIN, OHIO.

## DATA RELATING TO THE CO-EFFICIENT OF DISCHARGE.

| | |
|---|---|
| Method Number | 2. |
| Average boiler pressure | 68 lbs. |
| Average pressure head on pump | 32 lbs. |
| Average number of strokes per min. | 90. |
| Piston speed ft. per min. | 150. |
| Duration of Test | 1 hr. 11' - 30". |
| Theoretical discharge during test | 12702 gals. |
| Actual discharge during Test | 10582 gals. |
| Co-efficient of discharge | 83.3 % |
| Theoretical discharge per hour | 10674 gals. |
| Actual discharge per hour | 8891 gals. |

# # # # # # # # # # #

## DURBIN, OHIO.

### TABULATED RESULTS OF TESTS AND INSPECTION.

| | |
|---|---|
| Water pumped per 24 hrs. | 27000 gals. |
| Work performed per 24 hrs. | 10489702 ft. lbs. |
| Work performed from one pound of coal | 31780 ft.lbs. |
| Coal burned per 1000 gals. of water pumped | 12.2 lbs. |
| Coal burned per 24 hrs. | 329 lbs. |
| Coal burned per month | 9870 lbs. |

# # # # # # # # # # #

### REMARKS.

The pump at this station is the same as the one at Pekin, and the amount of work done per pound of coal is taken from that test.

As the pumpman is car inspector ther would be no object in using a gasoline engine at this plant to save cost of attendance.

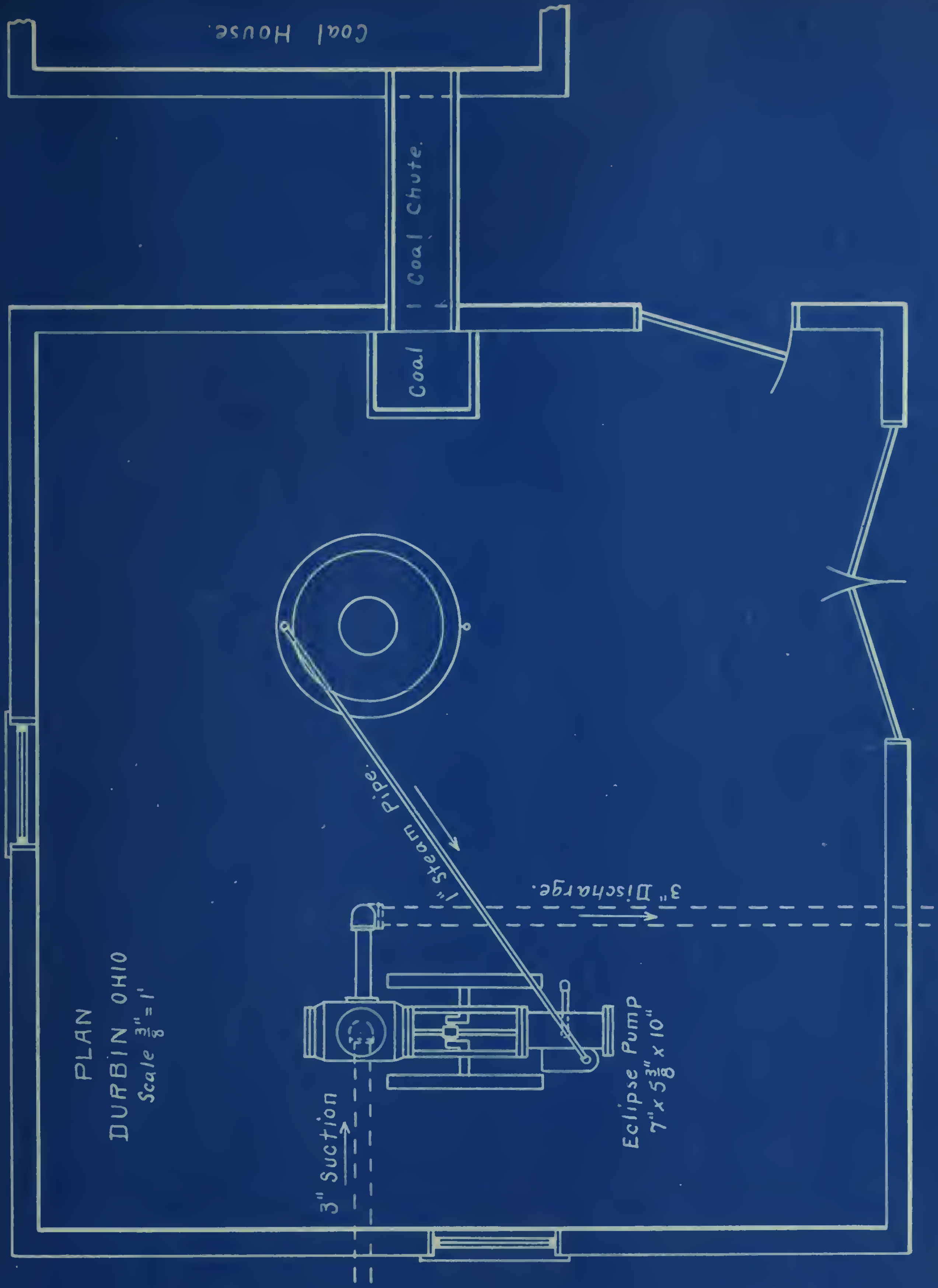
The well here receives surface water at times when the water is high in the creek.

## DURBIN, OHIO.

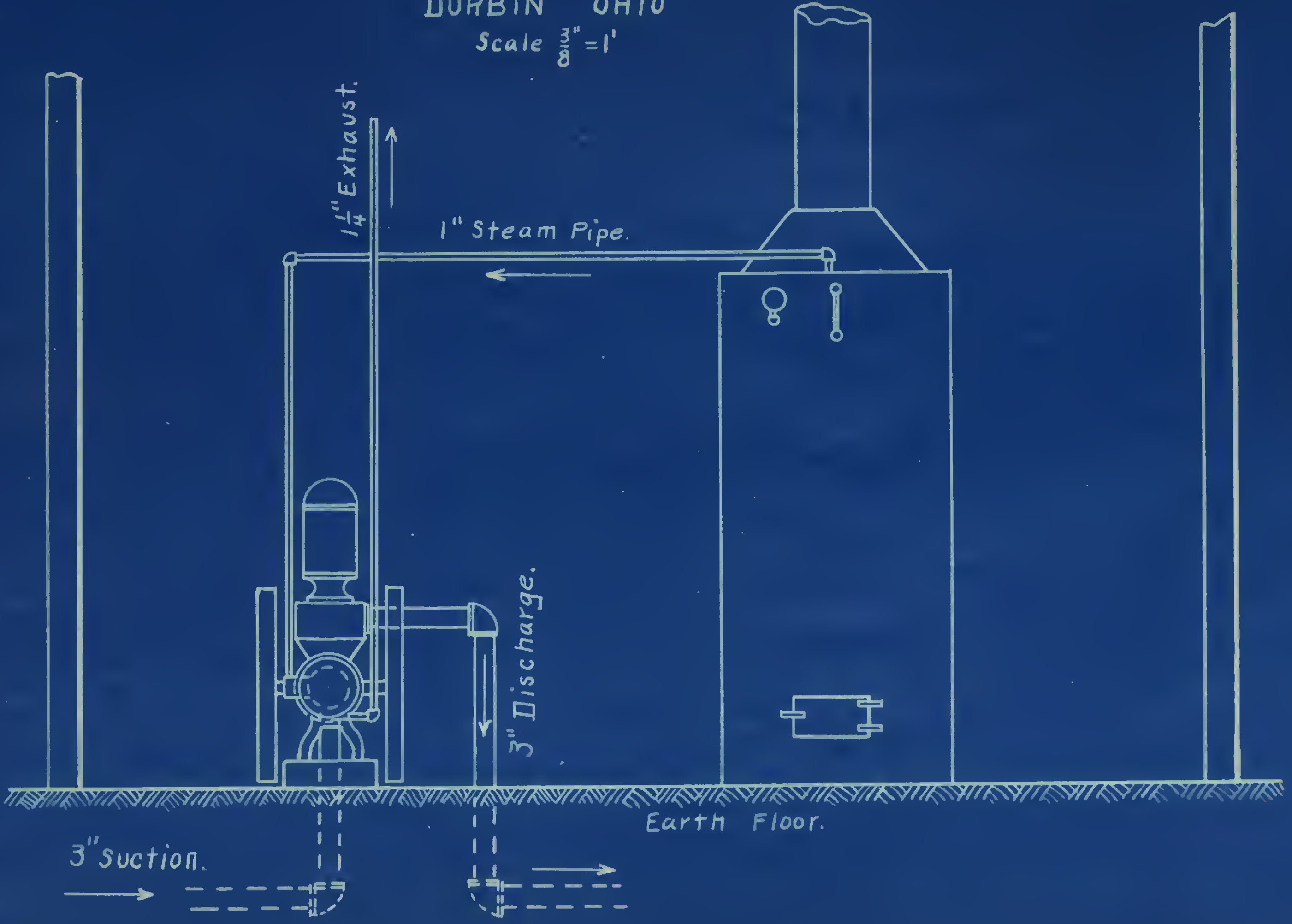
### RESULTS OF ESTIMATES ON COSTS.

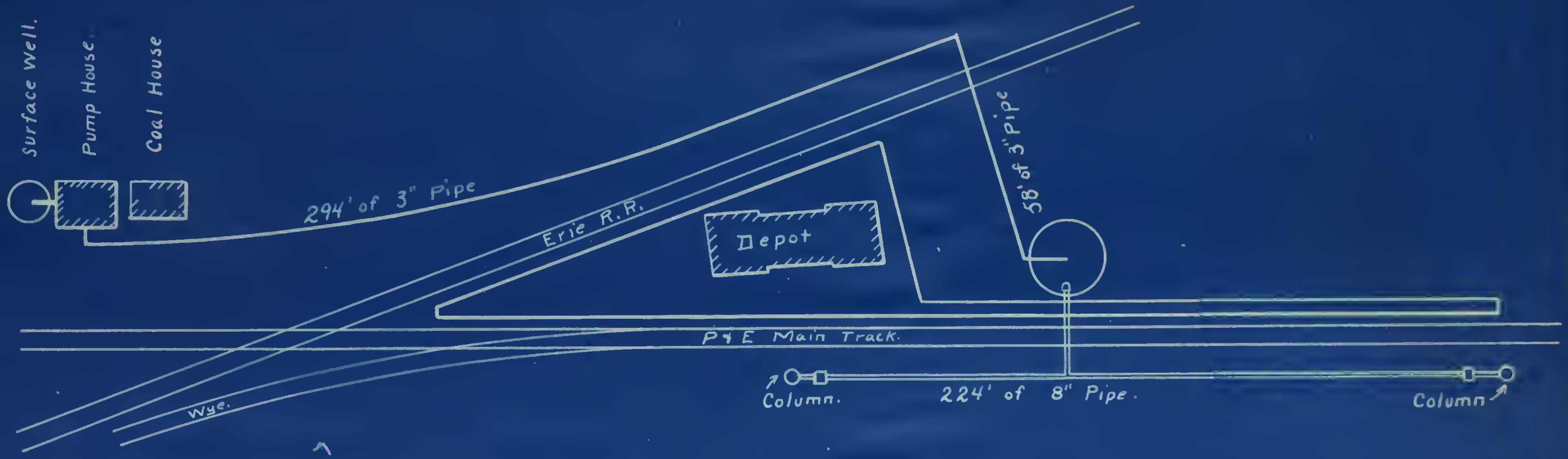
| | |
|---|---|
| Cost of plant complete | $6115.00 |
| Cost of repairs per month at 3 % per year | 10.~~00~~20 |
| Amount of depreciation of plant per month @ rate of 5 % per year | 25.48 |
| Interest on investment per month @ rate of 5 % per year | 25.48 |
| Cost of labor per month | 15.00 |
| Cost of supplies per mpnth | 5.00 |
| Cost of coal per month @ $1.10 per ton | 5.42 |
| Total cost of pumping per month | 76.58 |
| Total cost of pumping 1000 gallons | .094 |
| Cost of coal per 1000 gallons pumped | .0067 |

# # # # # # # # # # # #


Coal House.
Coal Chute.
Coal
1" Steam Pipe.
3" Discharge.
3" Suction
Eclipse Pump
7" x 5 3/8" x 10"
PLAN
DURBIN OHIO
Scale 3/8" = 1'

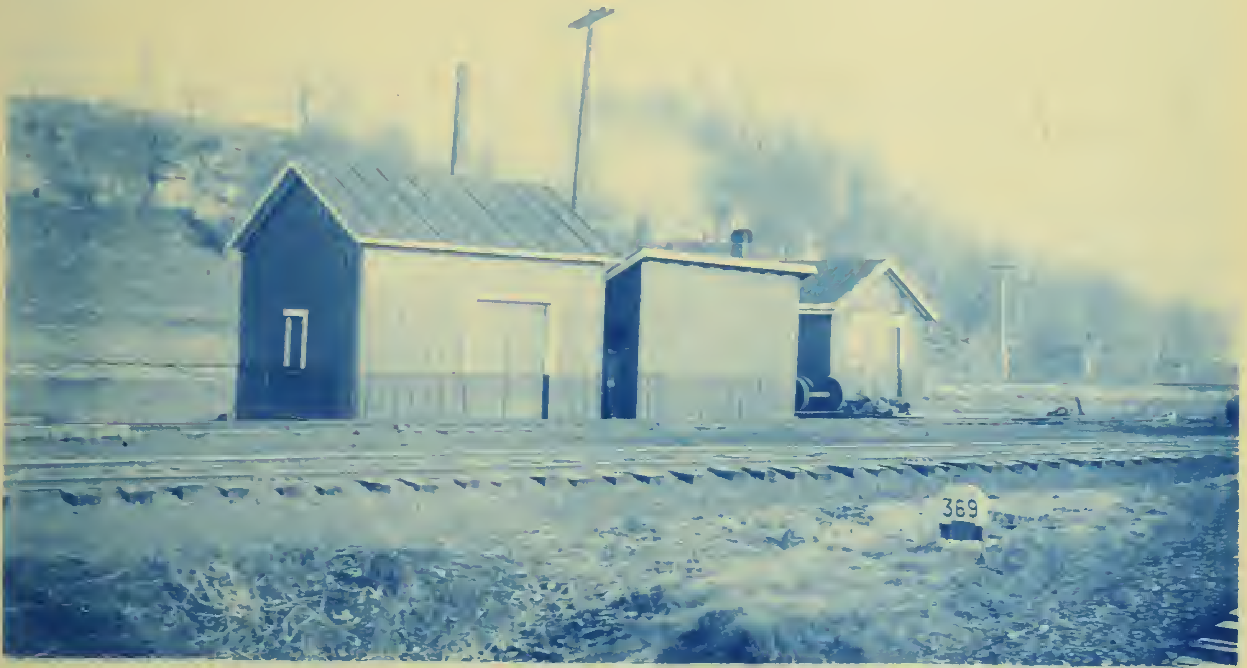
ELEVATION
DURBIN OHIO
Scale $\frac{3}{8}'' = 1'$


1¼" Exhaust.
1" Steam Pipe.
3" Discharge.
Earth Floor.
3" Suction.


Surface Well.
Pump House
Coal House
294' of 3" Pipe
Erie R.R.
Depot
58' of 3" Pipe
P & E Main Track.
Wye.
Column.
224' of 8" Pipe.
Column

GENERAL PLAN
DURBIN OHIO.
Scale 1" = 40"

Durbin.


369

Durbin.

FARMER CITY, ILLINOIS.

WATER STATION ON THE PEORIA

AND EASTERN RAILWAY.

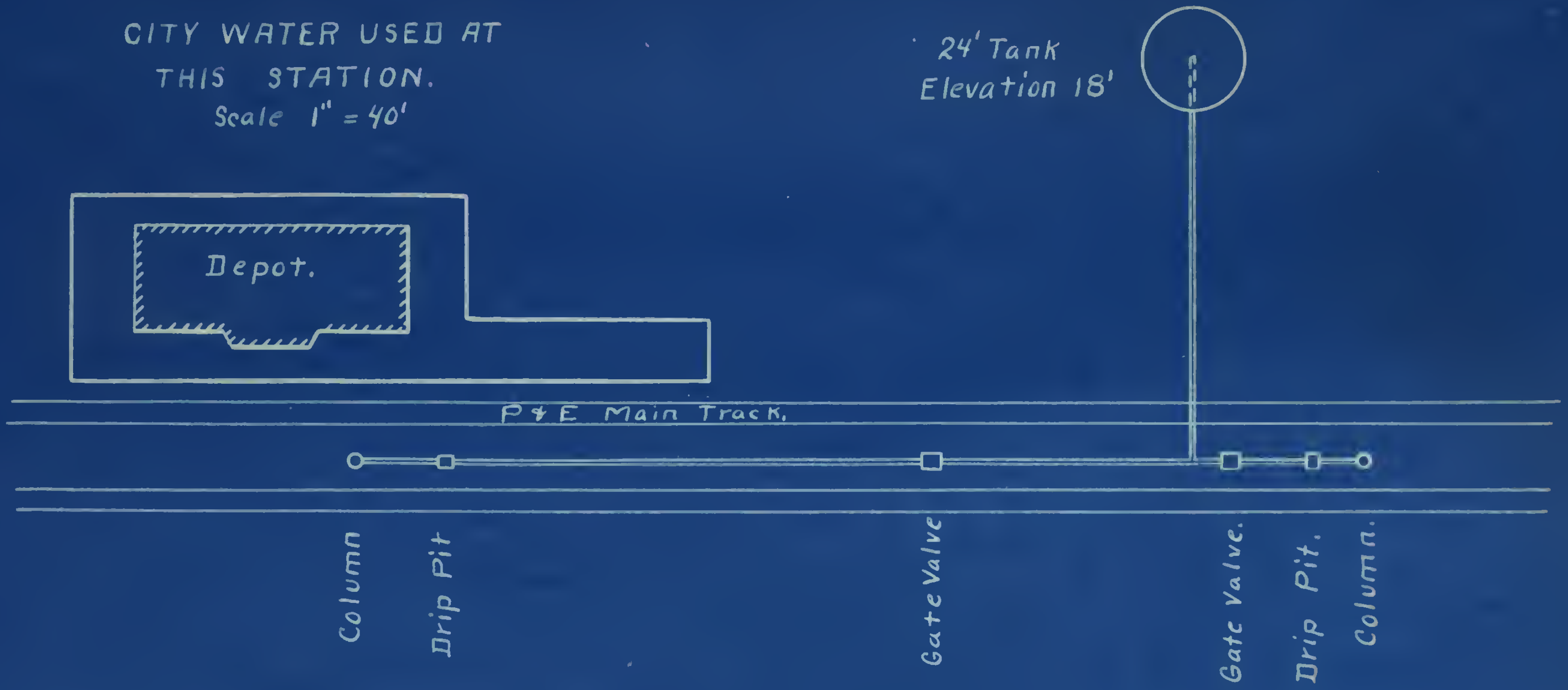
E

Farmer City.

# NEW CASTLE, INDIANA.

# WATER STATION ON THE PEORIA AND EASTERN RAILWAY.

GENERAL PLAN
NEW CASTLE IND
CITY WATER USED AT
THIS STATION.
Scale 1" = 40'


24' Tank
Elevation 18'
Depot.
P & E Main Track.
Column
Drip Pit
Gate Valve
Gate Valve.
Drip Pit.
Column.

New Castle.

# PAXTON, ILLINOIS.

# WATER STATION ON THE

# ILLINOIS CENTRAL RAILROAD.

# PAXTON, ILLINOIS.

## DATA RELATING TO THE CO-EFFICIENT OF DISCHARGE TEST.

| | |
|---|---|
| Test Number | 1. |
| Method Number | 2. |
| Average Number of strokes per min. | 26. |
| Piston speed per min. | 104. |
| Duration of Test | 2 1/2 hrs. |
| Theoretical discharge during test | 20912. |
| Actual discharge during test | 9326. |
| Co-efficient of discharge | 44.6 |

# # # # # # # # # # #

| | |
|---|---|
| Actual amount pumped per hour | 3730 gals. |

## PAXTON, ILLINOIS.

### DATA RELATING TO THE EFFICIENCY TESTS.

| Number of Test | 1. | 2. |
|---|---|---|
| Duration of Test | 5 1/4 hrs. | 2 1/2 hrs. |
| Actual amount of water pumped during during test | 19913 gals. | 9964 gals. |
| Gasoline used during test | 6.828 gals. | 3.17 gals. |
| Water pump per gallon of gasoline | 2916 gals. | 3143 gals. |
| Gasoline used per 1000 gals. of water pumped | .343 gals. | .320 gals. |
| Work performed per gallon of gasoline in ft. lbs. | 4256080. | 4663924. |
| Gasoline required to perform 1000000 ft. lbs. of work | .234 gals. | .214 gals. |

# # # # # # # # # # #

# PAXTON, ILLINOIS.

## DATA RELATING TO THE EFFICIENCY TESTS.

(Continued.)

| | | |
|---|---|---|
| Cost of gasoline used in pumping 1000 gallons | $0.034 | $0.032 |
| Cost of gasoline used in performing 1000000 foot pounds of work | .0234 | .021 |

# # # # # # # # # # # #

| | |
|---|---|
| Average Indicated Horse Power | 7.96 |
| Horse power performed in lifting water | 2.784 |

Efficiency $\frac{\text{Water Horse Power}}{\text{Indicated Horse Power}} = 35\%.$

# # # # # # # # # # #

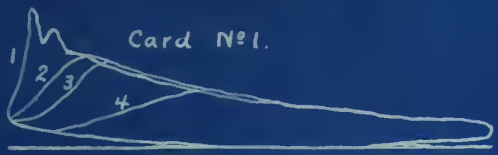
# INDICATOR CARDS TAKEN FROM A 12 HORSE POWER FAIRBANKS MORSE AND CO GASOLINE ENGINE.

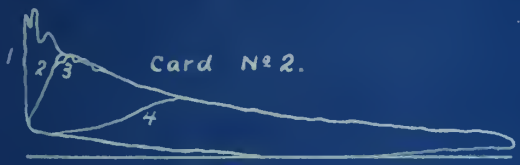
## PAXTON ILL.

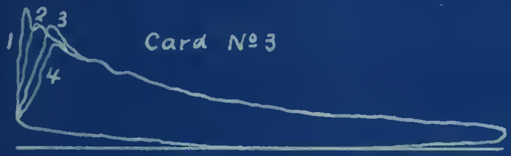
Station on the Illinois Central R.R.

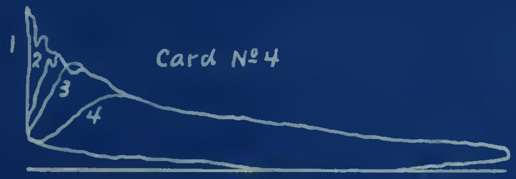
THESIS

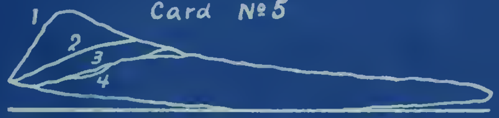
F. J. BIRD.

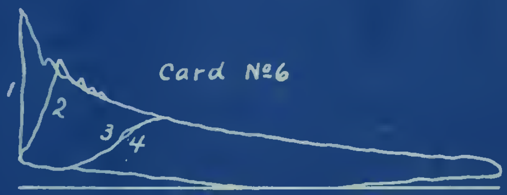

Card Nº 1.

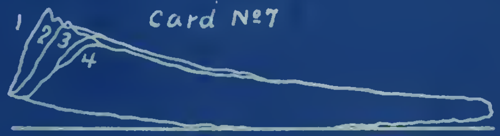

Card Nº 2.

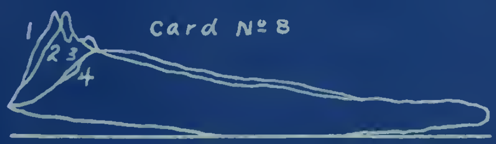

Card Nº 3


Card Nº 4


Card Nº 5


Card Nº 6


Card Nº 7


Card Nº 8

## PAXTON, ILLINOIS.

### RESULTS OF INDICATOR CARDS.

| Card Number | Diagram Number. | Area of Diagram | Length of Diagram | Average area of Diagrams | Explos'n | Average I H P |
|---|---|---|---|---|---|---|
| 1. | 1. | .64 | 2.55 | .55 | 54. | 7.92 |
| | 2. | .60 | " | | | |
| | 3. | .59 | " | | | |
| | 4. | .37 | " | | | |
| 2. | 1. | .60 | " | .52 | 55. | 7.46 |
| | 2. | .55 | " | | | |
| | 3. | .57 | " | | | |
| | 4. | .37 | " | | | |
| 3. | 1. | .59 | " | .57 | 57. | 8.48 |
| | 2. | .57 | " | | | |
| | 3. | .57 | " | | | |
| | 4. | .56 | " | | | |
| 4. | 1. | .60 | " | .54 | 59. | 8.30 |
| | 2. | .53 | " | | | |
| | 3. | .53 | " | | | |
| | 4. | .47 | " | | | |

## PAXTON, ILLINOIS.

### RESULTS OF INDICATOR CARDS.

| Card Number | Diagram Number. | Area of Diagram | Length of Diagrams | Average Area of Diagrams | Explos'n | Average I H P |
|---|---|---|---|---|---|---|
| 5. | 1. | .57 | 2.55 | .48 | .59 | 7.38 |
| | 2. | .49 | " | | | |
| | 3. | .46 | " | | | |
| | 4. | .40 | " | | | |
| 6. | 1. | .65 | " | .54 | .55 | 7.74 |
| | 2. | .55 | " | | | |
| | 3. | .48 | " | | | |
| | 4. | .48 | " | | | |
| 7. | 1. | .62 | " | .56 | .56 | 8.18 |
| | 2. | .58 | " | | | |
| | 3. | .50 | " | | | |
| | 4. | .54 | " | | | |
| 8. | 1. | .63 | " | .59 | .55 | 8.46 |
| | 2. | .62 | " | | | |
| | 3. | .57 | " | | | |
| | 4. | .57 | " | | | |

## PAXTON, ILLINOIS.

### DATA FROM INSPECTION OF PLANT.

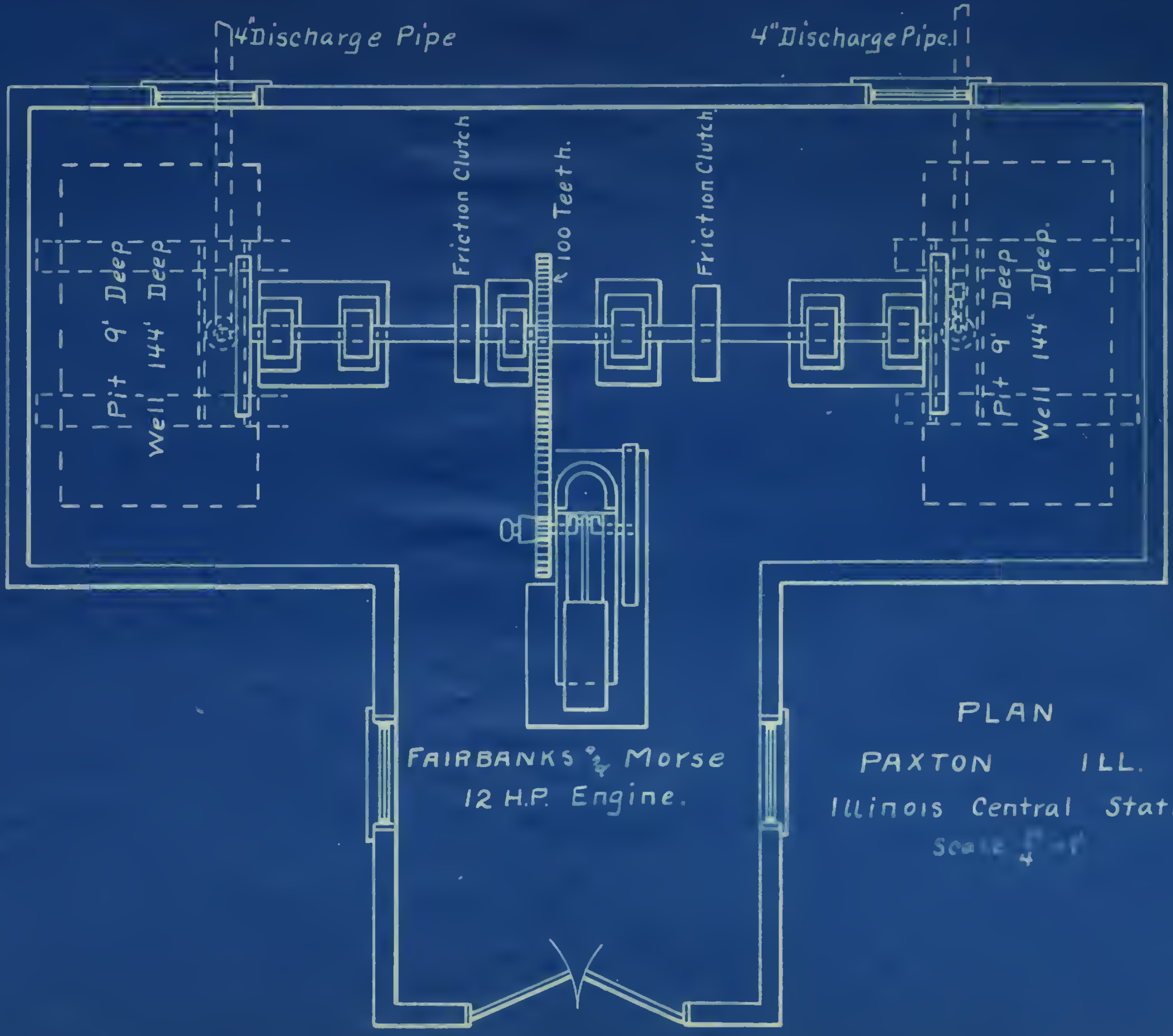
| | |
|---|---|
| Date of Test and Inspection | May 2, 1901. |
| Make of Pump | F. M. & Co. |
| Make of Gasoline Engine | F. M. & Co. |
| Number of hours pump is in operation | 16. |
| Height of Discharge | 168. |
| Size of Tank | 22" x 16". |

# # # # # # # # # # #

### REMARKS.

The pumps at this station need repair. The co-efficient of discharge is very low and accounts for the very small ratio between the Water Horse Power and the Indicated Horse Power. The engine was being operated by a hot tube igniter. The cards show that the ignition is too late in many cases.

# # # # # # # # # # #


4" Discharge Pipe
4" Discharge Pipe.
Pit 9' Deep
Well 144' Deep
Friction Clutch
100 Teeth.
Friction Clutch
Pit 9' Deep
Well 144' Deep.
FAIRBANKS & Morse
12 H.P. Engine.

PLAN

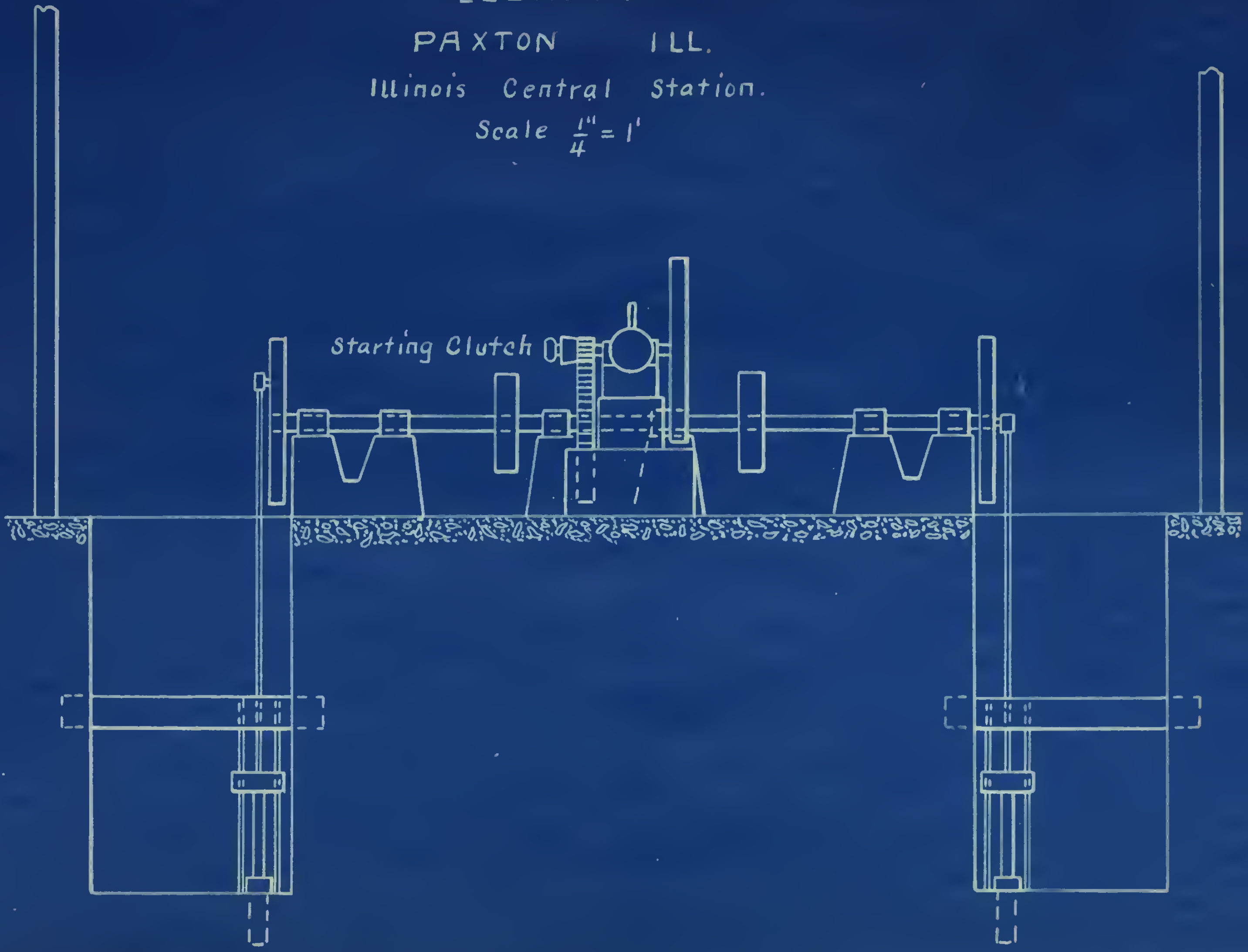
PAXTON ILL.
Illinois Central Station
Scale $\frac{1''}{4}=1'$

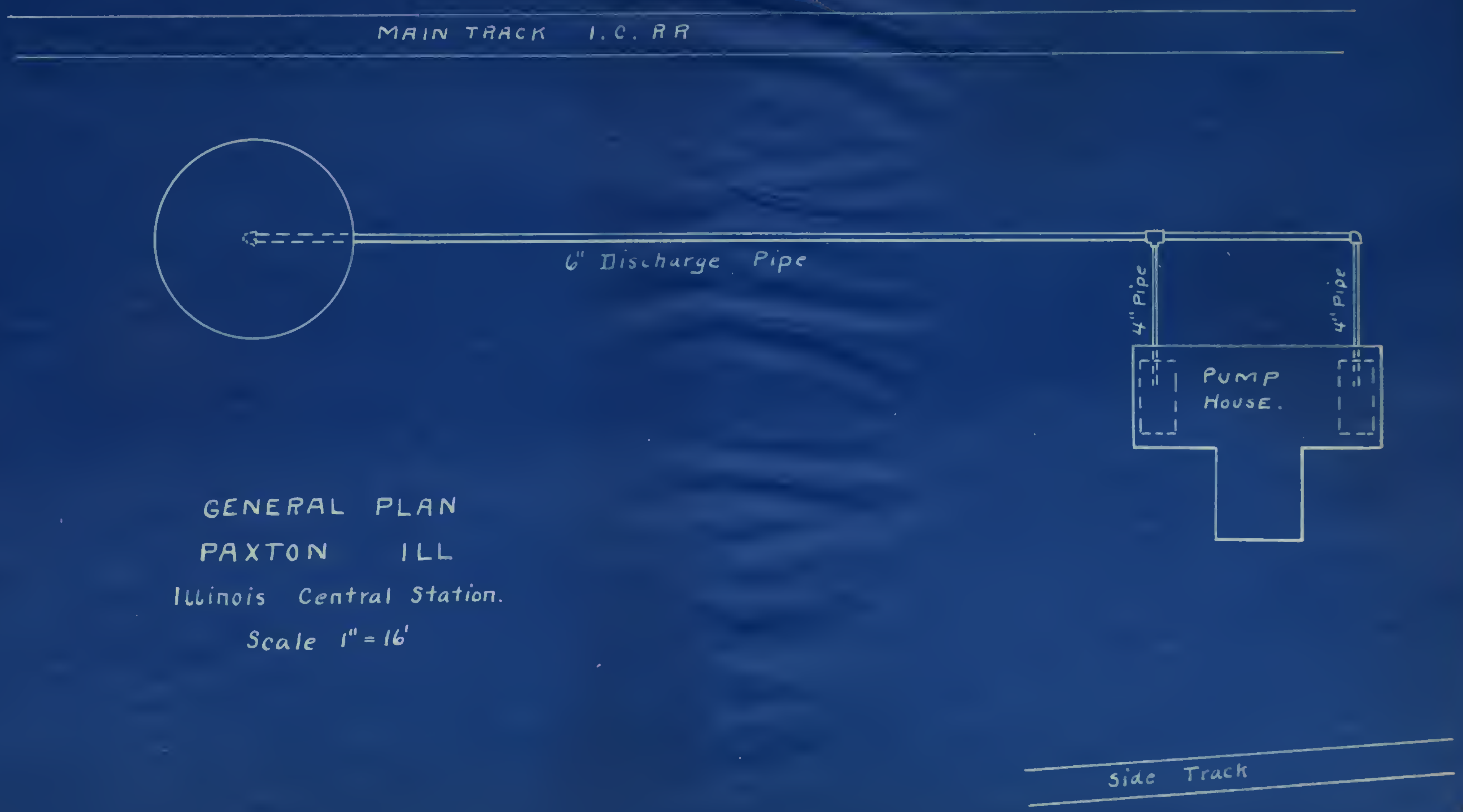
# ELEVATION

PAXTON ILL.

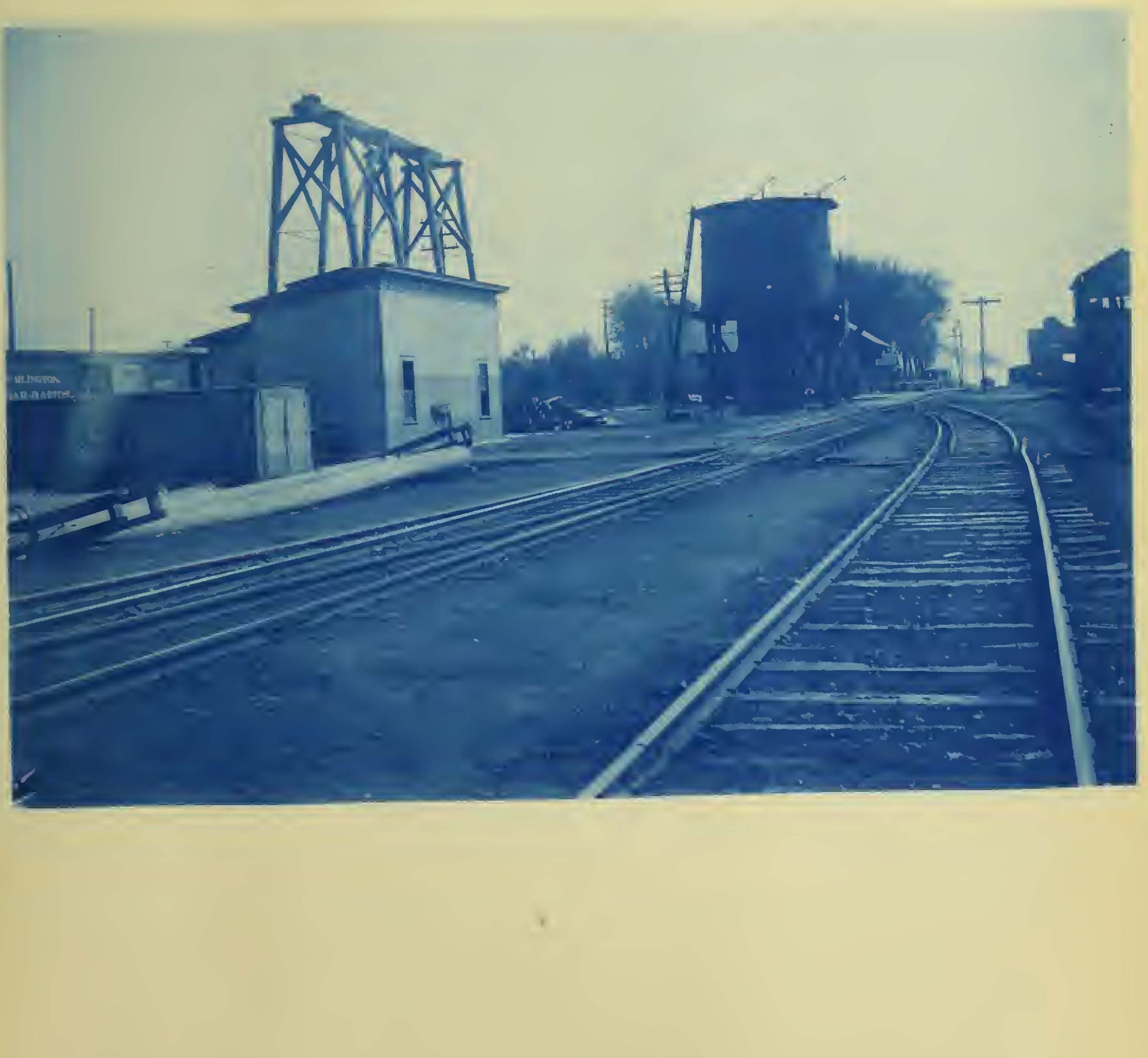
Illinois Central Station.

Scale $\frac{1''}{4} = 1'$


Starting Clutch


MAIN TRACK I.C. RR
6" Discharge Pipe
4" Pipe
4" Pipe
PUMP HOUSE.
Side Track

GENERAL PLAN
PAXTON ILL
Illinois Central Station.
Scale 1" = 16'


RLINGTON
AR RAPIDS

PAXTON

PAXTON

## SUMMATION OF TESTS.

| | Eclipse Pump. | Dean Pump. | Cook Pump. |
|---|---|---|---|
| Average co-ef. of discharge | 86.9 % | 96.3 % | 87.4 % |
| Ft. lbs. of work performed per pound of coal | 31780 | 73013 | 49780 |
| Coal consumed in performing 1000000 ft.lbs. of work | 31.4 lbs. | 13.7 lbs. | 20.1 lbs. |
| Cost of coal consumed in performing 1000000 ft. lbs. of work | $.0165 | $.0075 | $.011 |

# # # # # # # # # # #

## REMARKS.

The Dean pump shows the best results of any of the pumps installed. Where the water in the deep wells rises near the surface it would seem more advisable to install the Dean pump in preference to the Cook pump.

# # # # # # # # # # #

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| | LL | | WATER COLUMNS | | TOTAL COST TO DUPLICATE PLANT COMPLETE $ | REMARK |
|---|---|---|---|---|---|---|
| | DEPTH * | COST $ * | NO. IN USE | COST OF EACH | | |
| ER<br>R | | 250 | NONE | 190 | 5150 | TANK COST $1400. SUPPORTS<br>TANK FOUNDATION COST $4 |
| D | 212' | 318 | 2 | " | 7097 | H=HORIZONTAL. V=VERT |
| | 165' | 371.25 | 2 | " | 5640 | *INFORMATION FURNISHE |
| 0' | 10' | 50 | 2 | " | | E=ESTIMATED. |
| D<br>ED | 15' | 700 | 3 | " | 188.42 | L. OF SUPPLY PIPE INCLUDES PIPE<br>+ THE 3 COLUMNS. OIL ENG. PIPIN |
| D<br>D | 8' | 300 | 2 | " | 7515 | |
| DD | 5' | 75 | 2 | " | 5087 | 2 SUCTION PIPES. 1 DEL<br>PUMPS USED. ONE AT A TIME. |
| | | 250 | 3 | " | | |
| EK | 10' | 50 | 2 | " | | THIS IS AN EMERGENCY PL |
| D | 225' | 506.25 | 2 | " | 6971 | |
| R | | 50 | 2 | " | 8035 | |
| D | | 215 | 1 | " | | |
| | 68' | 460 | 2 | " | 7574 | BOILER USED FOR OTHER PU<br>PUMPING. |
| | 219' | | 2 | " | 5894 | |
| | D=15'<br>31' | 100<br>100 | 3 | " | 7229 | |
| | D=15<br>17' | 75 | 2 | " | 6185 | |
| | 20'8" | 50 | 2 | " | 6473 | |
| B | ' | 50 | 3 | " | 6115 | |

## CHEMICAL ANALYSIS.

The chemical analysis show that at several stations the water is very bad. The installation of purification plants would be expensive and the benefits would not in all cases pay for the outlay. If the water at some of these stations could be treated with soda ash as has been suggested, the water could be improved a great deal. This soda ash could be placed in the well or in the tank. If placed in the tank, the tank would need washing out quite often.

# # # # # # # # # # #

## TABLE OF ESTIMATES MADE FOR A CERTAIN WESTERN RAILROAD BY A WATER PURIFICATION COMPANY.

| Station Number | Capacity per 24 hrs. Gals. | Cost of treating 1000 gals. Cents. | Total Cost per 24 hrs. | Cost of Apparatus. |
|---|---|---|---|---|
| 1. | 27000. | 2 1/4 | $ .60 | $3500.00 |
| 2. | 30303 | 2 3/4 | .81 | 3500. |
| 3. | 37168 | 2 3/4 | .91 | 3500. |
| 4. | 34880. | 3 1/4 | 1.12 | 4000. |
| 5. | 30000. | 2 | .60 | 3500. |
| 6. | 20215. | 2 | .40 | 3000. |
| 7. | 163460. | 2 | 3.26 | 4500. |
| 8. | 25000. | 2 1/4 | .56 | 3000. |
| 9. | 39450. | 1 3/4 | .67 | 3500. |
| 10. | 102840. | 2 | 2.04 | 4000. |
| 11. | 10000. | 1 1/2 | .15 | 1500. |
| 12. | 30000. | 1 3/4 | .51 | 4000. |
| 13. | 45000. | 2 1/4 | 1.01 | 3500. |
| 14. | 22302. | 1 1/2 | .33 | 3500. |
| 15. | 173690. | 1 3/4 | 3.02 | 4500. |
| 16. | 30000. | 1 3/4 | .51 | 3500. |
| 17. | 30000. | 7 | 2.10 | 3500. |
| 18. | 88050. | 6 1/2 | 5.72 | 3500. |
| 19. | 21108 | 3 1/2 | .73 | 3000. |
| 20. | 20000. | 1 1/4 | .25 | 4500. |
| Totals. | 980466. |  | 25.30 | 70500. |

## CALCULATED SAVING PER YEAR ON
## THE SAME RAILROAD IF WATER WAS TREATED.

### Annual Saving.

| | |
|---|---|
| Total saving in repairs estimates at 50 % of total | $7424.00 |
| Saving in Material ~~due to decrease~~ | 3976.00 |
| " due to decrease in fuel consumption | 13923. |

Total Saving --------------------$25323.00

### Additional Expense.

| | |
|---|---|
| Interest @ 4 % on the original investment of $70500.00 | $2820.00 |
| Actual average annual cost of operation | 9234.00 |
| Annual depreciation & repairs @ 8 % | 5640.00 |

Total Expense -------------------$17694.00

Net Saving = $25323 - $17694 = $7629.00

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# GASOLINE ENGINES.

From the tabulated results of tests on gasoline engines which are used for pumping water it is seen that the average cost of per forming one million ft. lbs. of work is $.0232. From the tests of steam pumps, the results show that the average cost of performing one million ft. lbs. of work is .0116. As these tests cover a wide range of conditions it is safe to say that as far as fuel is concerned the steam pump is the more economical.

The makers of gasoline engines claim that the engine needs so little attention that the station agent can attend to the starting and stoping of the pump. Several railroads who have followed this plan find that the cost of repairs under these circumstances is considerably greater than the wages of the attendants.

From the information at hand it is fair to assume that if the pumps needs an attendant there is no advantage in installing gasoline engines. As a means of doing away with the large repair bill, some railroads have a man experienced in gasoline engine operation to take charge of several different stations. On the Illinois Central Railroad, this plan is used and on the division in which Paxton is located the man, who has charge of this work had three or four helpers so that it is likely that the cost of labor in this case would be the same as in the case where each station has its attendant.

The tests at Paxt~~t~~on show very poor results. In this station there is a great deal of loss in the gearing and line of

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# TABULATED DATA ON GASOLINE ENGINES WHICH ARE USED FOR PUMPING WATER

THESIS DRAWING.

F.J. BIRD.

| LOCATION OF PLANT. | INSTALLED BY WHOM. | OWNER. | MAKE OF PUMP | MAKE OF ENGINE. | SIZE OF PUMP | SIZE OF ENGINE. HORSE POWER | GALLONS OF WATER PUMPED DURING TEST. | GALLONS OF GASOLINE USED DURING TEST. | DELIVERY HEAD IN FEET. | SUCTION HEAD IN FEET. | GALLONS OF WATER PUMPED PER GALLON OF GASOLINE. | FT. LBS. WORK PERFORMED PER GALLON OF GASOLINE. | DURATION OF TEST. | COST OF GASOLINE PER 1000000 FT. LBS. OF WORK PERFORMED | COST OF GASOLINE PER 1000 GALLONS OF WATER PUMPED. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COHASSETT MASS. | F. C. COFFIN | WATER CO | BLAKE. | HORNSBY AKROYD. | Tri Single 6½" x 8" | — | 11914000. | 1745. | 160 | — | 6827 | 9126333 | 115 Days | $.0109 | $.0147 |
| WINCHESTER, MASS. | F. C. COFFIN | WATER CO | BLAKE. | HORNSBY. AKROYD. | Tri Single 8½" x 12" | 20 | 106163. | 10.876 | 142 | — | 9761 | 11516518. | 5 Hours | .0086 | .0102 |
| WESTVILLE N.J. | | | | | | 13½ | 4627. | 1. | 242 | — | 4627 | 11288305 | 32 Min. | .0088 | .0214 |
| " " " | | | | | | " | 3494. | 0.5 | 200 | — | 6988 | 11676948 | 20 " | .0085 | .0143 |
| GENEVA ILL. | | C & N.W. Ry | | OTTO | Single A. 5¾" x 19" | 9 | 7320000 | 1213.7 | 48 | 3 | 6031 | 4171000 | 150 Days | .0239 | .0166 |
| WELDON SLIP. | | ILL. Cen. R.R. | | OTTO | Triplex Sin. 5½" x 8" | 5 | 15464 | 1.995 | 22 | 8 | 7751 | 2439000 | 3 Hours | .0410 | .0115 |
| RICHMOND ILL | | C. & N.W. Ry | | OTTO | Triplex Single 5" x 6" | 3½ | 1842000 | 246 | 46 | 10 | 7487 | 2858000 | 12 Mo. | .0350 | .0134 |
| BOURBON ILL | | C. & E.I. Ry | | OTTO | Double. A. 5" x 15" | 6 | 26965 | 2.9 | 40 | 15 | 9298 | 4260000 | 6 Hours. | .0234 | .0108 |
| CLINTON IND | | C. & E.I. Ry. | | OTTO | Double. A. 6" x 18" | 10 | 36180 | 2.25 | 63 | 13 | 16080 | 7370000 | 4 Hours | .0135 | .0062 |
| " " | | C. & E.I. Ry | | OTTO | Double A 6" x 18" | 10 | 31320 | 2.71 | 63 | 13 | 11550 | 5290000 | 3.5 Hours | .0189 | .0086 |
| " " | | C. & E.I. Ry. | | OTTO | Double A 6" x 18" | 10 | 67500 | 4.96 | 63 | 13 | 13608 | 7162774 | 7.5 Hours | .0139 | .0074 |
| WELLINGTON | | C & E I Ry | | F.M. & Co. | | 3 | 532560 | 55.4 | 35 | 10 | 9612 | 2810789 | 131.6 " | .0356 | .0104 |
| BARRE PLAINS | | Boston & Maine | | F.M. & Co. | | | 24000 | 1.73 | 22 | — | 13873 | 2549996 | 4 Hours | .0393 | .0072 |
| URBANA ILL. | | UNIVERSITY | CURTIS | OTTO | | 10 | 15520 | 1.06 | 22 | | 14533 | 2671310 | 2 Hours | .0374 | .0068 |
| URBANA ILL. | | " | " | OTTO | | 10 | 15092 | 1.08 | 28 | | 13975 | 3269311 | " " | .0306 | .0071 |
| URBANA ILL | | " | " | OTTO | | 10 | 14302 | 1.14 | 41 | | 12547 | 4298037 | " " | .0233 | .0080 |

ESTIMATED COST OF GASOLINE = 10¢ PER GALLON.

shafting but it seems to be the system which is most used for lift pumps.

Since this appears to be a necessary arrangament in the combination of gasoline engines and lift pumps, it is probable that under ordinary circumstances a gasoline engine is not as economical where operated with a lift pump as where used in connection with the ordinary suction to which it can be directly geared.

# # # # # # # # # # #

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